SEWAGE AND INDUSTRIAL WASTES

(Formerly Sewage Works Journal)

JOURNAL of the FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

Special Features

Contamination of Irrigated Vegetables—Rudolfs, et al.

Gravity Oil-Water Separators—Giles, et al.

Plating Wastes Treatment—Cooper

1951 YEARBOOK AND DIRECTORY

MARCH, 1951—VOL. 23, No. 3

Make Plans to Attend

TWENTY-FOURTH ANNUAL MEETING

OF THE

FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

IN CONJUNCTION WITH

CENTRAL STATES SEWAGE WORKS ASSOCIATION

MUNICIPAL AUDITORIUM

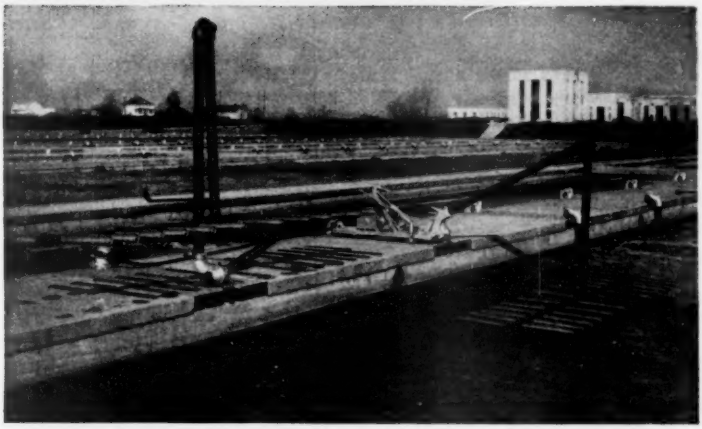
ST. PAUL, MINN.

October 8-11, 1951

FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

325 ILLINOIS BUILDING CHAMPAIGN, ILLINOIS

THE OVERWHELMING MAJORITY *specified* "CHICAGO" SWING DIFFUSERS AND PRECISION TUBES



Sewage Treatment Plant
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Paul A. Uhlmann & Associates
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THE overwhelming majority of Consulting and Design Engineers who planned equipment for Activated Sludge Sewage Treatment Plants in the past five years specified CHICAGO Swing Diffusers and Precision Diffuser Tubes. It's a question of "Diffused Air Economics". Continuous operation of an Aeration Battery is possible only with Swing Diffusers. The most economical operation is possible with Precision Diffuser Tubes.

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- **Continuous performance without extra tanks.**
- **Economical operation—less power consumed—less labor.**
- **Tubes easily and economically cleaned.**

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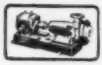

Flush Kleen. Screw-Feller. Plunger. Horizontal and Vertical Non-Clogs Water Seal Pumping Units Samplers

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SEWAGE AND INDUSTRIAL WASTES

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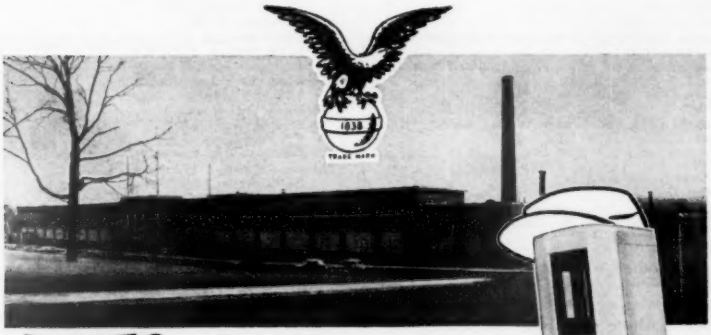

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HOW TO MEASURE TRADE WASTES ACCURATELY

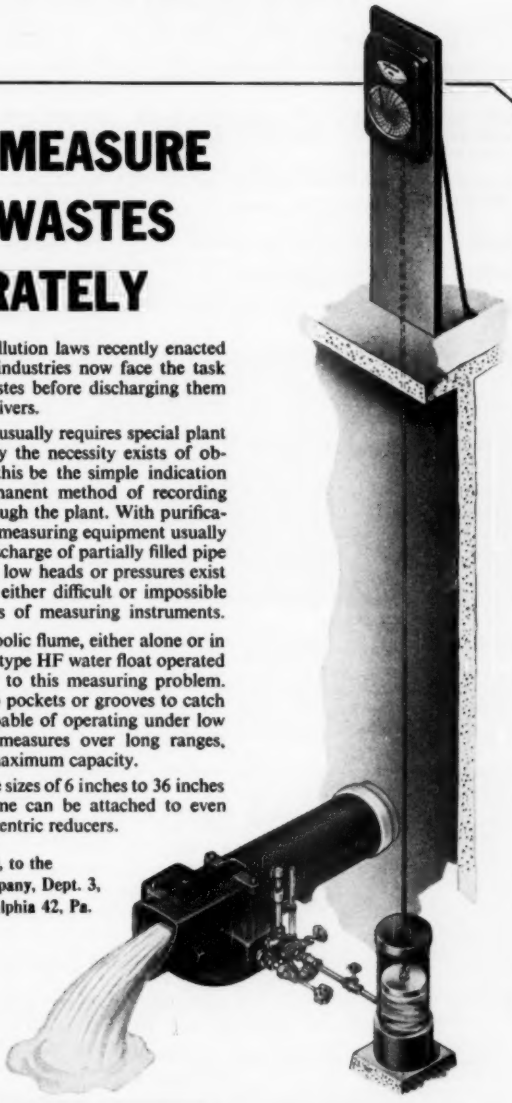
In accordance with anti-pollution laws recently enacted by numerous states, most industries now face the task of purifying their plant wastes before discharging them into adjacent streams and rivers.

This purification process usually requires special plant construction, and invariably the necessity exists of obtaining flow data, whether this be the simple indication of flow rate or a more permanent method of recording and totalizing the flow through the plant. With purification processes of this kind, measuring equipment usually is located at the point of discharge of partially filled pipe or in open channels, where low heads or pressures exist and where measurement is either difficult or impossible when using standard forms of measuring instruments.

The Simplex type S Parabolic flume, either alone or in conjunction with a Simplex type HF water float operated meter, is the ready answer to this measuring problem. Compact in design, with no pockets or grooves to catch sediment or solids, and capable of operating under low flow conditions, the unit measures over long ranges, from maximum to 5% of maximum capacity.

Available in standard pipe sizes of 6 inches to 36 inches diameter inclusive, the flume can be attached to even larger sizes by means of eccentric reducers.

Write for Bulletin 210, to the Simplex Valve & Meter Company, Dept. 3, 6719 Upland Street, Philadelphia 42, Pa.



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MEMBER ASSOCIATION MEETINGS

Association	*Place*	*Time*
Arizona Sewage and Water Works Association	El Tovar Hotel, Grand Canyon, Ariz.	Mar. 28–30, 1951
Louisiana Conference on Water Supply and Sewerage	Louisiana State University, Baton Rouge, La.	Mar. 28–30, 1951
Virginia Industrial Wastes and Sewage Works Association	Hotel Chamberlin, Old Point Comfort, Va.	Apr. 5–6, 1951
Arkansas Water and Sewage Conference	Hot Springs, Ark.	Apr. 9–11, 1951
Kansas Sewage Works Association	Lamer Hotel, Hays, Kans.	Apr. 11–13, 1951
Montana Sewage Works Association	Hotel Placer, Helena, Mont.	Apr. 19, 1951
California Sewage Works Association	Hotel Californian, Fresno, Calif.	Apr. 25–28, 1951
Pacific Northwest Sewage Works Association	Hotel Vancouver, Vancouver, B. C.	May 15–16, 1951
Michigan Sewage and Industrial Wastes Association	Hotel Pantlind, Grand Rapids, Mich.	June 4–6, 1951
New York Sewage and Industrial Wastes Association and New England Sewage Works Association	Springfield, Mass.	June 7–8, 1951
Alabama Water and Sewage Association	University of Ala., Tuscaloosa, Ala.	June 15, 1951
Ohio Sewage and Industrial Wastes Treatment Conference	Neil House, Columbus, Ohio	June 20–21, 1951
Canadian Institute on Sewage Purification	Royal York Hotel, Toronto, Ont.	Aug. 20–22, 1951
Pennsylvania Sewage and Industrial Wastes Association	State College, Pa.	Aug. 22–24, 1951
Iowa Sewage Works Association	Hotel Tall Corn, Marshalltown, Iowa	Sept. 11–13, 1951
Kentucky–Tennessee Industrial Wastes and Sewage Works Association	Kentucky Hotel, Louisville, Ky.	Sept. 17–19, 1951
South Dakota Water and Sewage Works Conference	Charles Gurney Hotel, Yankton, S. Dak.	Sept. 19–21, 1951
Rocky Mountain Sewage Works Association	Cosmopolitan Hotel, Denver, Colo.	Sept. 26, 1951
North Dakota Water and Sewage Works Conference	Gardner Hotel, Fargo, N. Dak.	Sept. 26–28, 1951
Missouri Water and Sewerage Conference	St. Joseph, Mo.	Sept. 30–Oct. 2, 1951

Federation of Sewage and Industrial Wastes Associations
Municipal Auditorium, St. Paul, Minn.
October 8–11, 1951

Florida Sewage and Industrial Wastes Association	The Princess Issena Hotel Daytona Beach, Fla.	Oct. 28–31, 1951
New England Sewage Works Association	Sheraton-Biltmore Hotel, Providence, R. I.	Nov. 6–7, 1951
North Carolina Sewage and Industrial Wastes Association	Robert E. Lee Hotel, Winston-Salem, N. C.	Nov. 12–14, 1951

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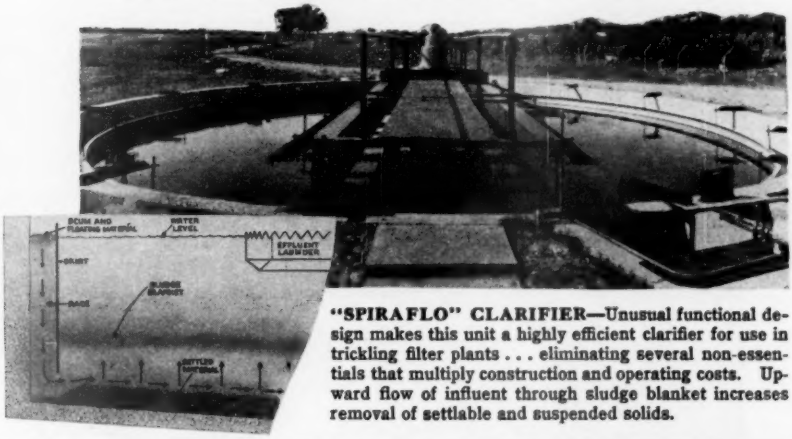

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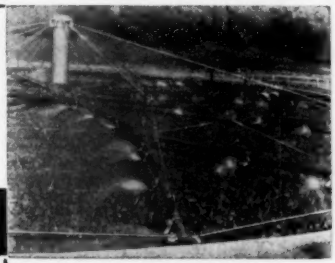

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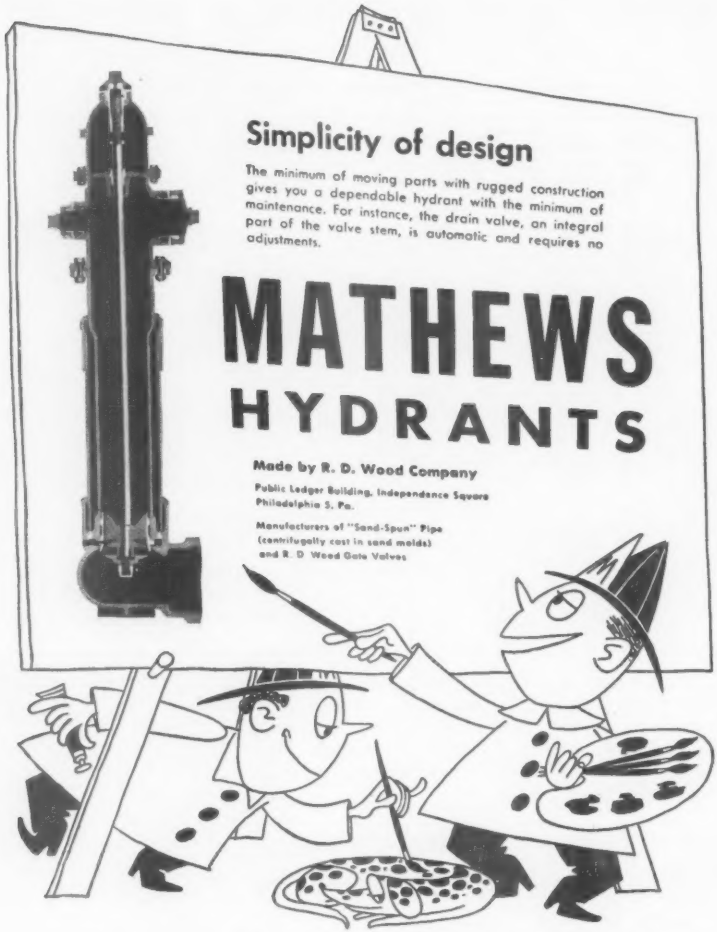
FIT ANY REQUIREMENTS—Overall plant efficiency is always higher when the two units are used in combination; however, plants using either type of equipment or the combination can be designed to fit any needs for treating domestic and industrial wastes.

IMPORTANT INFORMATION—Facts as to remarkable records established by Yeomans units will be helpful in your project planning. Bulletins containing performance data, field engineering data and construction cost estimates are available on request—use the coupon.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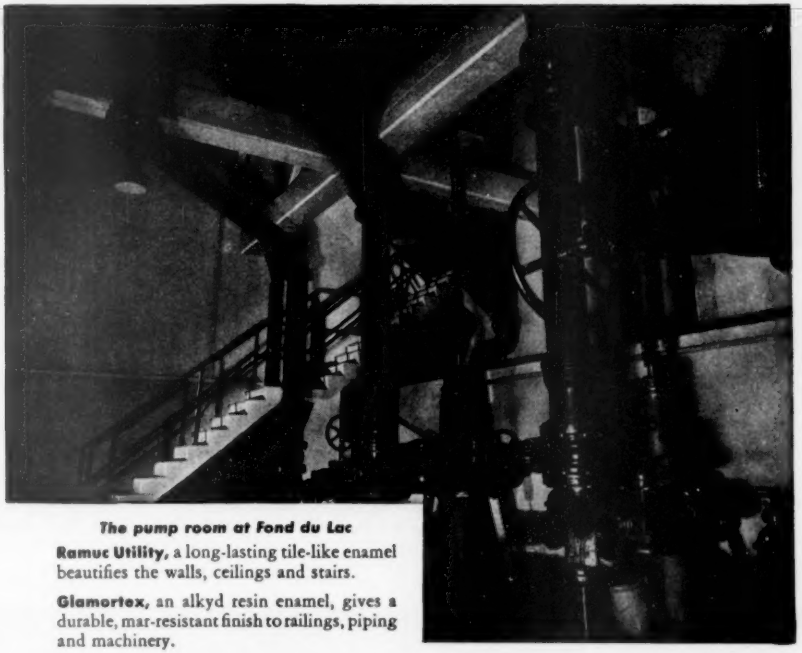

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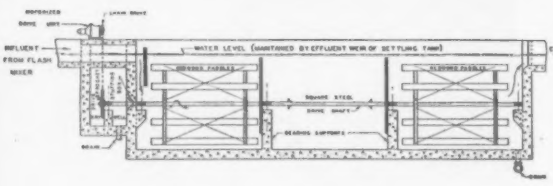

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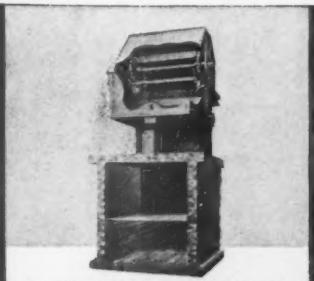
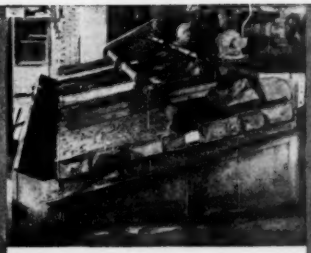


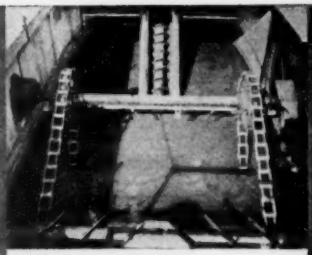
THRU-CLEAN BAR SCREENS

—a coarse bar rack and chain operated rakes equipped with fingers that clean through the rack from the back. The screen cannot be jammed by large objects since the rake will enter under and lift them. Send for Folder No. 2327.



LIQUID VIBRATING SCREENS

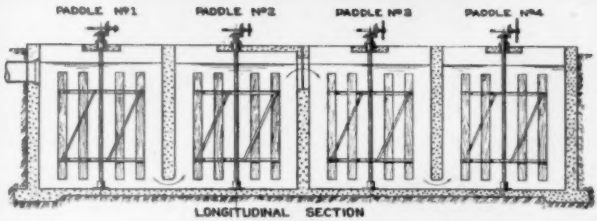
—an efficient and economical screen for the removal of solids from industrial liquids. Units are available in several sizes with coarse or fine screen medium. Send for Book No. 1977-A.



STRAIGHTLINE GRIT COLLECTORS

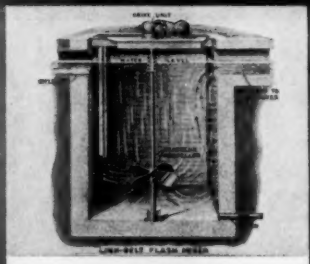
—for the removal of a clean, washed grit with a low putrescible content, the collecting and thorough cleaning operation with Link-Belt grit washer makes further handling unnecessary. Send for Book No. 1942.

COORDINATED FOR MOST EFFICIENT PERFORMANCE...



VERTICAL SLOW MIXERS

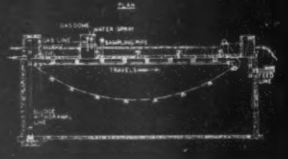
—for square tanks which can be constructed singly or in a series of two, three or four. These mixers will provide efficient mixing and flocculation where vertical flow is desired. The mixers can be operated at a decreasing rate of speed to produce the maximum size floc. Send for Folder No. 2042.



FLASH MIXERS

—for rapid and thorough mixing of chemicals with water, sewage or industrial liquids. A large, efficient four-blade propeller operates with or without under water bearing. Send for Folder No. 2042.

ONE HIGH STANDARD OF QUALITY...



STRAIGHTLINE SCUM BREAKERS

—are used in either round or rectangular digestion tanks to break up the floating scum, paddle it down and submerge it. The scum breaker consists of two stands of chain with pitched flights between them, traveling at a slow speed. Send for information.

● Link-Belt manufactures a complete line of equipment for Water, Sewage and Industrial Liquids Treatment Plants and have applied this equipment effectively to the solution of such problems. Link-Belt engineers have cooperated with consulting, municipal and sanitary engineers, and plant operators in planning and operating plants, for positive results and highest efficiency. For information on any of the above products, write your nearest Link-Belt office.

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And through Official Distributors and Representatives throughout the World

*Also Factory Branch Stores

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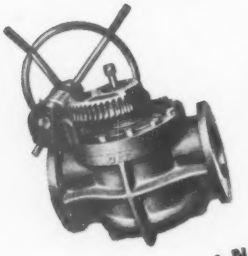

a.c.f. cylindrical plug valves

They alone provide the full-pipe-area passage, and straight-through round* porting, that can banish abrasion troubles. Lubricant-sealed from contact with the lading, the precision-machined plug does not wear or need attention, other than an occasional turn of the lubricating screw. Why use less efficient valves?

*Also available with full-pipe-area rectangular port.

a.c.f. CYLINDRICAL FULL PIPE AREA LUBRICATED PLUG VALVES

Representatives in more than 50 principal cities

Write for Catalog 4-SI, describing types and sizes, to: American Car and Foundry Company, Valve Division, 1501 East Ferry Ave., Detroit 11, Mich.

An Important Message for Everyone Who Buys Sewage Treatment Equipment

From Single Items To Complete Sewage Treatment Plants INFILCO Equipment Can Fill ALL Your Needs

Thinking about replacing old equipment or modernizing and increasing the capacity of a sewage treating plant? INFILCO can provide a complete range of equipment and control devices from which to choose.

Planning an entirely new plant? INFILCO offers you the advantage of a *one-source* supply for *all* your needs. Whether your plans call for chemical or biological treatment, you can depend upon INFILCO for the most modern equipment available . . equipment that will be modern *for years to come!*

A complete laboratory and staff of competent engineers are available for making recommendations and reports.

When considering your next sewage treatment plant or the modernization of an existing plant—consider the advantages of Infilco Service and Equipment. The Infilco Field Engineer is only a telephone call away. Consult your Classified Directory or write our executive offices in Tucson.

SEND FOR *8-page Bulletin No. 60-C. It contains illustrated descriptions covering the many superior advantages of Infilco Sewage Treatment Equipment.*

PRECISION ENGINEERED INFILCO SEWAGE TREATMENT EQUIPMENT

- Accelator®
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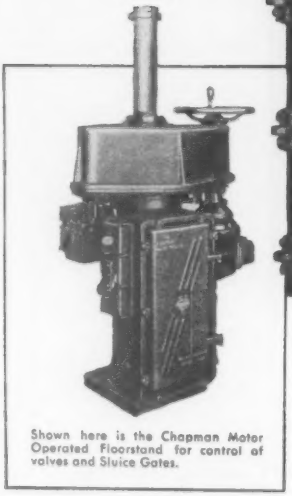
SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

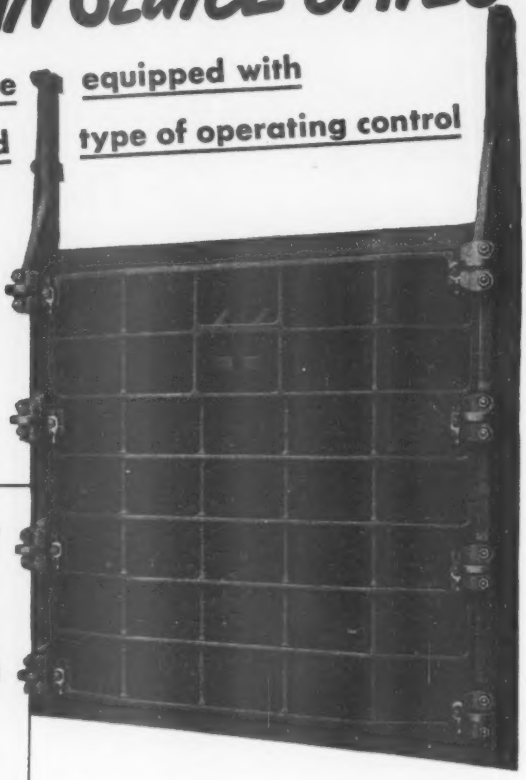
WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

CHAPMAN SLUICE GATES

can be equipped with any required type of operating control



Shown here is the Chapman Motor Operated Floorstand for control of valves and Sluice Gates.



Chapman Sluice Gates are available in standard sizes to meet practically all installation requirements. And, where necessary, many special sizes are also available from existing pattern equipment.

Sluice Gates can be equipped with any required type of operating control — manual, hydraulic cylinder or electric motor. No matter what your problem, there is a type of operating mechanism and a size to do your job.

Chapman Motor Units are completely factory wired and ready to operate on installation. Manual control, which utilizes the gear train for easy operation, is also provided for use in case of power failure.

THE CHAPMAN VALVE

Manufacturing Company, INDIAN ORCHARD, MASSACHUSETTS

. . . for proof of **better pumping performance!**

It's been said that split-case centrifugal pumps look pretty much alike. But looking alike does not mean "like" performance!

We've lifted the casing of a Fairbanks-Morse Single-Stage Split-Case Centrifugal to show you why you get *better* performance . . . *lower* maintenance costs with Fairbanks-Morse . . . to show you important design and manufacturing differences.

Note the sturdy construction and exceptional strength provided by the arched casing and solid pump base . . . the ease with which the entire pump can be inspected or the entire rotating element removed without disturbing driver or pipe connections. Exceptionally smooth water passages reduce friction and "back eddies" to the minimum. Bearing brackets, cast integrally with pump body, maintain accurate, permanent alignment of shaft and impeller Smooth, one-piece impeller reduces wear and maintains efficiency. Impeller is pressed on shaft over a key so that the key also drives the shaft sleeves and prevents destructive rotation of the sleeve on the shaft. Removable casing and impeller wearing rings assure easy maintenance and have streamlined water guiding surfaces for maximum pump efficiency.

These are but a few of the many performance-making features you'll find in Fairbanks-Morse Centrifugals. Your Fairbanks-Morse Pump expert will be happy to give you the complete story on these efficient, economical pumps. See him or write Fairbanks, Morse & Co., Chicago 5, Illinois.

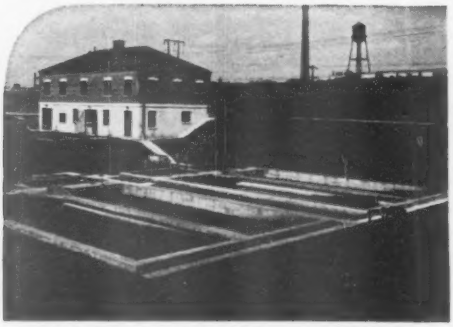
FAIRBANKS-MORSE,

a name worth remembering

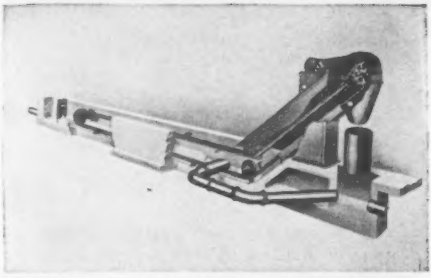
PUMPS • SCALES • ELECTRIC MOTORS
GENERATORS • LIGHT PLANTS • DIESEL,
DUAL FUEL AND GASOLINE ENGINES

for the "BIGS" and the "smalls"

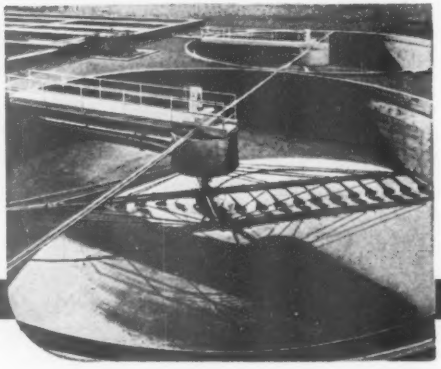
REX provides *proved* equipment!



REX CONVEYOR SLUDGE COLLECTORS combine the well-known advantages of the rectangular settling tank with a rugged and efficient form of sludge removal mechanism. Whether handling primary sludge or light flocculent solids, their performance is efficient and economical.



REX GRIT EQUIPMENT with its exclusive recirculating principle, effectively separates and removes inorganic solids from liquids. No grit washer is required. Rugged construction assures long, economical service.



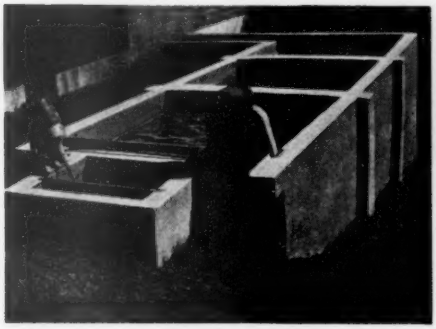
REX TOW-BRO SLUDGE COLLECTORS assure accurate control of sludge removal over a wide range of withdrawal rates through their exclusive suction principle. Sludge is removed immediately on contact instead of the usual plowing or scraping. Greater sludge concentration, greater operating flexibility, and a clearer effluent are a few of the many advantages.

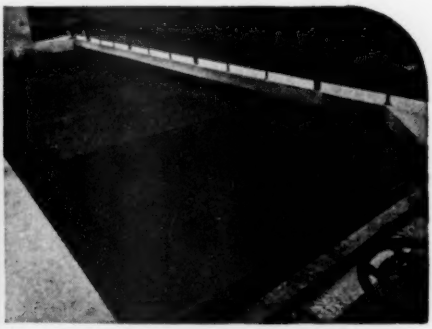
Large plant or small . . . primary or complete treatment . . . domestic or industrial waste, Rex Sanitation and Process Equipment is right for all.

Rex engineers consider the requirements of the small plant as well as the large . . . provide equipment that exactly suits the requirements. Equipment for the smaller plants is not just "scaled down" but is designed and built for the specific problems encountered. Conversely, large plant units are built for the job they must do.

Too, Rex answers the problem of the overloaded plant . . . offers equipment that can frequently expand existing capacities without enlargement of plant size.

In any plant, Rex provides unequaled efficiency . . . capacity . . . sets the standards for economical, long-life operation. Specially trained Rex sanitation engineers will be happy to assist you with your individual problems. For complete information, write for your copy of Bulletin 48-41. Chain Belt Company, 1606 West Bruce Street, Milwaukee 4, Wisconsin.

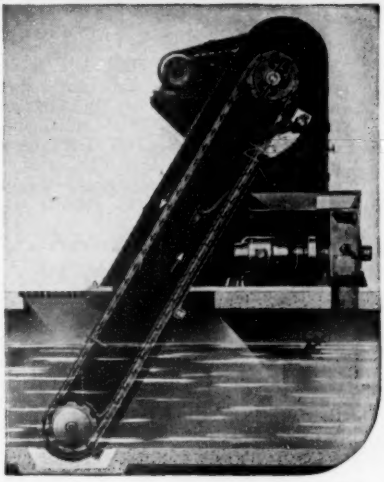




REX SLO-MIXERS AND FLASH MIXERS assure rapid disbursement of chemical throughout the liquid, followed by a gentle, multi-stage slow mixing for optimum floc formation. Rex Slo-Mixers eliminate short-circuiting and effect savings in chemicals.

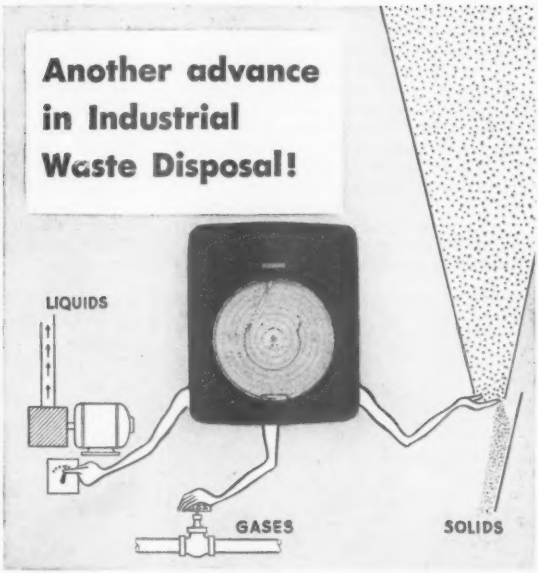
REX VERTI-FLO delivers a highly clarified effluent with an extremely short detention period. It provides maximum tank capacity for any desired tank size and maximum practical weir length. The combination of large weir length and low vertical velocities assures a clearer effluent, far greater capacity at minimum cost.

REX MECHANICALLY CLEANED BAR SCREENS AND TRITURATORS are neat, streamlined units that provide an efficient means of removing large solids from liquids and reducing them in size. Reduced material is returned into the sewage flow for quick and efficient handling in settling tanks and digesters.



CHAIN BELT REX COMPANY

SANITATION EQUIPMENT



AUTOMATIC CONTROL for Proportioning of Treating Chemicals

Feeding of treating chemicals at rates proportionate to flow can *now be done automatically* — with total elimination of time-consuming, periodic adjustment of feeders and pumps. In addition, the proportioning of chemicals is far more accurate, which means a more uniform, satisfactory effluent and a definite saving in cost of chemicals.

The instrument control system is properly engineered for individual plant conditions. Its design depends upon the quantity, corrosive quality, and viscosity of the activated silica, carbon dioxide, soda ash, lime, or other chemicals employed . . . also upon the amount of chemicals to be stored and the type of plant operation.

Virtually *any* set of conditions can be met with one or another of the following instrument control methods offered by Foxboro:

1. *ratio flow control with pneumatic control valves for liquid chemicals or gases.*

2. *control of motor operation on dry feeders or on proportioning pumps by "pulse-time" control.*

3. *motor speed control on dry feeders or proportioning pumps through electronic control of power input.*

One of these methods may bring substantial new economies to the operation of your waste disposal system. For engineering briefs on industrial waste surveys, chemical control systems, and disposal methods, write **The Foxboro Company, 1623 Neponset Ave., Foxboro, Mass., U.S.A.**

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INDICATING • RECORDING • CONTROLLING

Pekrul Gates

MANUFACTURERS OF
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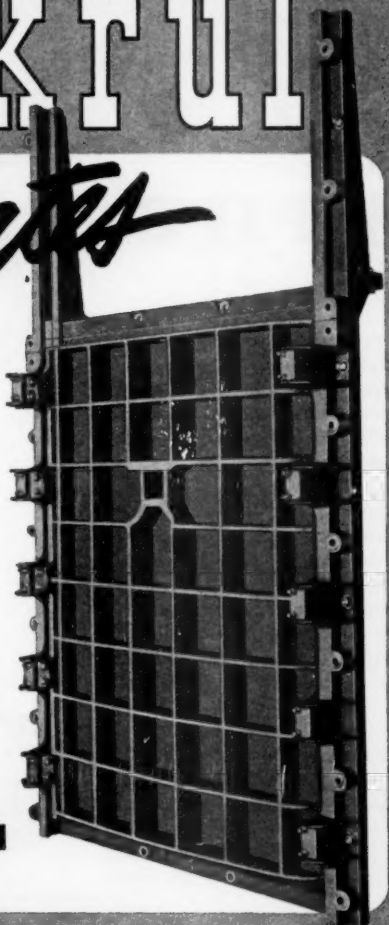
Cooling Towers



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MORSE BROS. MACHINERY CO.
DENVER, COLORADO
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formed under vacuum for greater strength

Vitrified CLAY PIPE

DE-AIRING — a process that makes Clay Pipe *stronger* for greater load-bearing, *denser* for less absorption, and dimensionally *truer* for faster installation — takes place in a vacuum press as the pipe is precision-formed under pressures as high as 75 tons.

De-airing, like the exclusive Vitrification process, is an outstanding example of technology at work for you . . . bringing you *better* Clay Pipe — stronger, denser, truer lengths for every sewerage and drainage use. Industry-wide research is constantly improving the traditionally high quality of Vitrified Clay Pipe — and developing new test procedures to *insure* consistent standards.

Vitrified Clay Pipe requires no "extras" . . . no special coatings to protect it from deterioration. It is corrosion-proof *throughout* — completely immune to destructive chemicals in soil, sewage, or industrial waste. You can specify it *safely*, with complete assurance that Clay Pipe *never wears out.*

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SPECIFY *Vitrified* CLAY PIPE

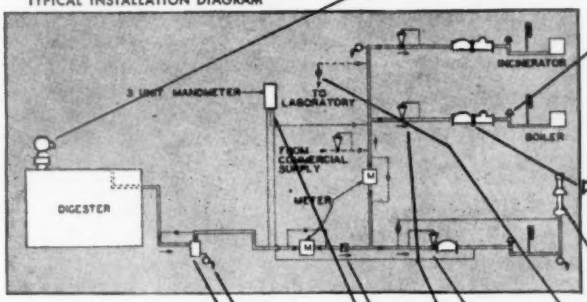
WRITE FOR DETAILED INFORMATION

Additional information and data on Vitrified Clay Pipe, Wall Coping and Clay Flue Lining sent FREE on request. State your specific questions. Simply contact the regional office nearest you.

CLAY PIPE NEVER WEARS OUT! PIPE

C-151-9

TYPICAL INSTALLATION DIAGRAM



Plan with "Varec" Symbols of Safety

FOR GAS CONTROL THROUGHOUT YOUR SEWAGE TREATMENT PLANT

"VAREC" Pressure Relief and Vacuum Breaker Valve with Flame Arrester — Fig. 5800C — Relieves excess pressures and vacuum in digesters and protects vessels from outside fires.

"VAREC" Explosion Relief Valve—Fig. 70 — Relieves sudden surges in pressure from explosion or momentary plant fluctuations.

"VAREC" Flame Trap Assembly—Fig. 450—Prevents flame propagation in piping.

"VAREC" Waste Gas Burner—Fig. 236, 237 or 238—Efficiently burns all excess gas.

"VAREC" Flame Check — Fig. 51A or 52A — Prevents flashback from burner pilot or laboratory burners.

"VAREC" Pressure Relief and Flame Trap Assembly—Fig. 440—Permits excess pressure to be wasted through gas burner and prevents flame flashback from burner.

"VAREC" Pressure Reducing Regulator—Fig. 187 or 387—Controls pressure of gas going to utilization equipment.

"VAREC" Check Valve —Fig. 211 or 211A—Controls direction of gas flow.

"VAREC" Manometer —Fig. 215, 215A, 216 or 216A — Indicates system pressures.

"VAREC" Drip Trap—Fig. 245 or 248.

"VAREC" Sediment Trap — Fig. 230, 232 or 233 — Keeps lines drained and free from moisture.

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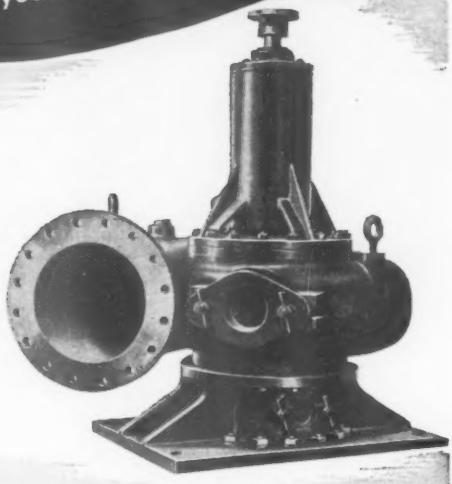
THE VAPOR RECOVERY SYSTEMS COMPANY

COMPTON, CALIFORNIA, U. S. A.

S-10 *Available from Authorized Sewage Equipment Agents throughout U. S. and Canada.*

when it's pumps, think of Economy

backed by over thirty years of specialized experience



The Mixed Flow Volute Pump illustrated is just one of the many types in the extensive line manufactured by Economy Pumps, Inc. Available in capacities to 80,000 G.P.M., it is designed for service where large volumes of liquids without heavy solids are to be handled at high speeds.

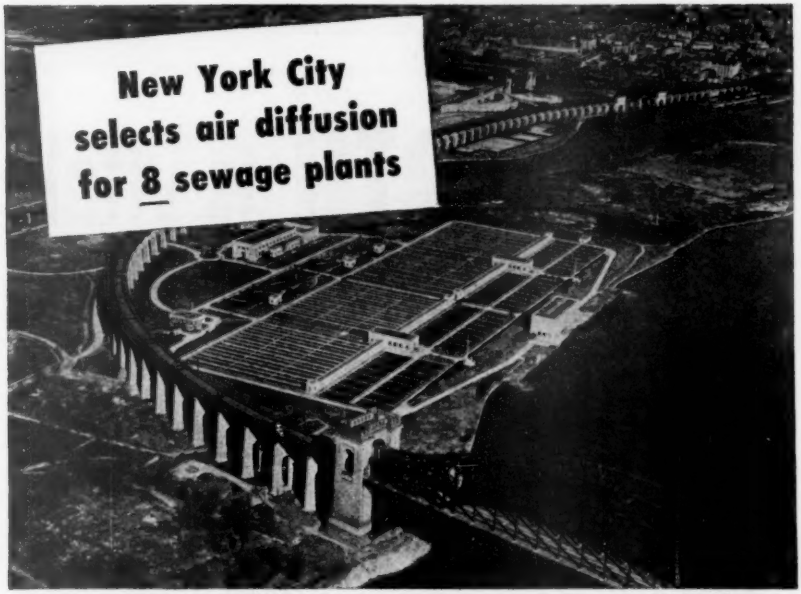
Maintenance expense is held to a minimum. Case records show Economy Pumps operating for fifteen to twenty years without replacement of major parts. However, should repairs be necessary, all parts subject to wear are renewable.

Catalog No. F-1049 gives complete design and construction details. Address Dept. AC-3 for your copy.

Centrifugal, Axial and Mixed Flow Pumps for all applications

Economy Pumps Inc.

DIVISION OF HAMILTON-THOMAS CORP., HAMILTON, OHIO



Information Courtesy Dept. of Public Works, New York City — Photo by Fairchild Aerial Surveys, Inc.

The vital importance of air diffusion processes to New York City's extensive pollution control program was at once evident to its engineers. Five large plants now use activated sludge or modified aeration treatment, three more are under construction, and several others are planned.

This type of aeration gives the high degree of treatment—at low cost—needed to meet New York City's acute conditions. Dense population, limited plant sites, and odor control are all critical factors.

Porous ceramic diffuser plates and tubes *have been used exclusively* for this program. *And* ALOXITE *aluminum oxide diffusers are installed in four of the five aeration plants now operating—and will be installed in all three under construction.*

May we send you our new booklet, "Porous Media for Filtration and Diffusion"? Its 56 pages are crammed with useful data. No obligation, of course.

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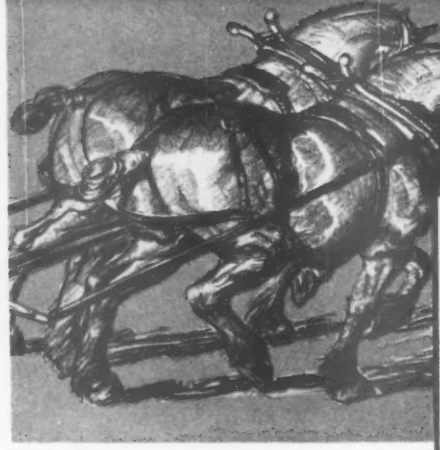

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SEWAGE AND INDUSTRIAL WASTES

Journal of the Federation of Sewage and Industrial Wastes Associations

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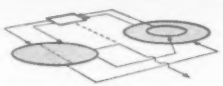

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Sewage Works

CONTAMINATION OF VEGETABLES GROWN IN POLLUTED SOIL *

I. BACTERIAL CONTAMINATION

By Willem Rudolfs, Lloyd L. Falk, and Robert A. Ragotzkie

The purpose of the investigations reported in this series of papers was to evaluate by field and laboratory experimentation:

1. The factors involved in the contamination of vegetables grown in polluting environments.
2. The survival of enteric bacterial and animal pathogenic or parasitic organisms.
3. Methods for cleaning vegetables which may become contaminated through growth or handling.

The survival of various enteric organisms on vegetables growing in the field and the comparison of the concentrations of organisms on vegetables growing in a polluted environment with those on vegetables in a normal environment were considered lines of research which would be indicative of the likelihood of raw vegetables being vectors for the transmission of human enteric diseases. In this respect, the importance of sewage irrigation and use of sewage sludge as fertilizer or soil builder is obvious.

The tomato was selected for the majority of these studies because it is one of the most common fruits eaten raw; grows relatively close to the ground, where contamination might be picked up from polluted soil; the plants can be trained to prevent contamination by splashing of the fruit; fruit can be exposed to the sun or left in the shade; and the skin of the fruit is smooth, but contamination can lodge in cracks and crevices of the skin. Some experiments with lettuce, spinach, and carrots were made, particularly to determine the effect on the extent of contamination and on the difficulties in decontamination of the irregular and rough surfaces of the vegetables and the tendency of soil and dirt particles to adhere to these surfaces.

In the survival studies the following organisms were used: the coliform group, *Salmonella* and *Shigella* species; *Endamoeba histolytica* cysts; and *Ascaris* eggs. Suspensions of organisms and feces were applied to the plants in the laboratory and in the field. Plants were grown under normal field conditions with and without sewage farming practice.

The various methods used for decontamination included storage; washing with water, detergent solutions, decontamination formulations, and germicidal rinses; treatment with gases; and application of heat.

General Methods and Materials

As has been pointed out in the survey of the literature (7), normal healthy fruits and vegetables are internally sterile. The problem of evaluating the contamination of a vegetable involves, then, the determination of the number of surface contaminants.

The coliform group has been used as the principal bacterial indicator of pollution in most water supply and waste treatment problems involving consideration of public health. The

* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, N. J.

wide usage of this group has been due principally to its ease of identification, its universal presence in the digestive tract of humans, and the somewhat greater resistance of the members of this group than of other bacterial intestinal pathogens to external conditions. Absence of members of the coliform group would fairly well assure absence of other intestinal bacteria. Kehr and Butterfield (4), upon examining available data as to the relationship of numbers of coliforms to *E. typhosa* in raw sewage, indicated that the probable ratio of the latter per million coliforms might lie between 3, at a typhoid morbidity of 0.01 cases per 1,000 population per year, and 120, at a morbidity of 30 cases.

Bacteriological Enumeration of the Coliform Group

Coliform organisms, including *Escherichia coli*, become valuable indicator organisms for the probable extent of pollution on vegetables. Standard Methods (8) were followed for the evaluation of coliform organisms. Two media were used—Endo agar and the lactose broth presumptive test, followed by confirmation in brilliant-green lactose bile broth. Incubation for 24 hr. at 37° C. was found sufficient for colony development on Endo agar. Inoculated lactose and brilliant-green bile broth were examined for gas formation at the end of 48 hr. of incubation at 37° C.

It was found that Endo agar could be used with good precision when laboratory studies were carried out with pure cultures of *E. coli*. On the other hand, when plates were poured with soil or field-grown vegetable inocula, the identification of the typical dark-red coliform colonies was rendered difficult or impossible by the presence of many other types of colonies of varying shades of pink to red.

When development of gas in lactose broth was used, three tubes of broth per decimal dilution were planted. Gas development was considered a presumptive test for coliforms. Subsequent gas development after transfer to brilliant-green lactose bile broth was considered confirmation of the coliform group. Evaluation of the coliforms present was based on the confirmed values, using statistically computed tables giving most probable number (M.P.N.) of organisms.

A comparison of these methods was made on soil samples taken from a sewage irrigation farm. Samples of soil were collected in sterile wide-mouth bottles. In the laboratory, 10 g. of soil were weighed out and added to 90 g. of sterile dilution water. The soil was shaken approximately 2 min., settled 10 sec., and the supernatant suspension withdrawn for inoculation into lactose broth or Petri dishes receiving Endo agar. The lactose cultures were confirmed by brilliant-green.

The results of this test on 12 soil samples are shown in Table I. The brilliant-green bile confirmation of the lactose broth values was considerably lower, whereas the Endo agar values tended toward lower values than the

TABLE I.—Comparison of Counts of Coliforms in Soil Using Endo, Lactose, and Brilliant-Green Confirmation Techniques

Soil Sample	Coliforms per Gram of Soil		
	Endo Agar (M.P.N.)	Lactose Broth (M.P.N.)	Brilliant-Green Bile Confirmation (M.P.N.)
A	9,000	25,000	1,500
B	10,000	95,000	1,500
C	15,000	9,500	200
D	6,500	45,000	250
E	2,100	95,000	8
F	1,200	25,000	8
G	28,000	25,000	9,500
H	50,000	15,000	16
I	5,000	45,000	95
J	2,300	25,000	15
K	6,000	25,000	45
L	100,000	150,000	9,500
Median values	8,000	25,000	150

lactose broth, but were of the same order of magnitude. The Endo agar values for coliforms for the soil studied were high because of interference by organisms which would ferment lactose and which would be inhibited by brilliant-green. As sanitary bacterial examination utilize the results of the brilliant-green confirmation of lactose broth counts as a measure of coliform organisms, it was concluded that this test was preferable to an Endo agar count for the measurement of this group of organisms in these soils and, by the same token, on the crops growing on the soils. Endo agar can profitably be utilized for laboratory work when pure cultures of *E. coli* are used, because incubation time is shorter, transfers are not required, and the precision of plate counts is greater than the most probable number technique using multiple tubes per dilution.

Bacteriological Enumeration of the *Salmonella* and *Shigella* Types

For field and laboratory tests on pathogenic *Salmonella* and *Shigella* types it was necessary to have methods to distinguish these types from the coliform and other soil organisms.

The following media were studied for *Salmonella* isolation:

1. Desoxycholate citrate lactose sucrose agar (BBL).
2. *Shigella-Salmonella* agar (Difco).
3. Bismuth sulfite agar (Difco).
4. Desoxycholate agar (Difco).

The organism used, *Salmonella cerro*, obtained from Walter Reed Hospital, was most easily recognized on the bismuth sulfite agar as black colonies with metallic surfaces. Most coliforms and nearly all common soil organisms were inhibited.

The colonies of *Salmonella cerro* were further tested by agglutination for *Salmonella* antigen type O–XVIII.

A culture of *Shigella alkalescens* was obtained from Walter Reed Hospital. On desoxycholate agar (Difco) this organism produced smooth, colorless colonies with a ground-glass appearance, which could readily be recognized with a little experience.

No serological means of confirmation was available, but tests with sewage showed that the colonies could be fairly accurately counted in the presence of a mixed bacterial flora.

In evaluating *Salmonella* and *Shigella* concentrations, the plating technique of Heukelekian and Schulhoff (2) for *B. typhosa* in sewage was used. This consisted of inoculating, on the surfaces of the solidified selective media in Petri dishes, 1 ml. of the various dilutions of the material to be tested. The inoculated plates were placed open in the 37° C. incubator until dry, then closed and inverted. Counts were made after 24 hr. for *Salmonella* and after 48 hr. for *Shigella*.

This plating method is more satisfactory than the conventional poured plate because only surface colonies are formed and all bacteria produce colonies with normal characteristics. Because of the selective nature of the media, no contamination results from the air during drying.

Evaluation of Bacterial Concentration on Vegetables

Several methods for the determination of bacteria on vegetable surfaces have been tried by other investigators. Creel (1) used two methods. One consisted of rubbing the leaf or stem to be studied directly against the surface of the plated, hardened agar medium. The second involved washing these parts in small quantities of broth, which was then plated directly into the agar to be used.

Melick (5) first washed his plants (lettuce and radishes) in running water and rubbed them with hands protected by sterile rubber gloves. The vegetables were then rinsed two to three times with sterile water and then macerated with a few ml. of sterile water in a sterile mortar. The fluid

from the macerated plant, as well as the rinse waters, were plated in Endo agar in search of typhoid organisms.

Hogg (3) tested the coliform contamination of watercress by examination of the third of three successive washings in sterile water. Absence of coliforms in this wash was considered an indication of a clean vegetable.

Mills *et al.* (6) sought the presence of bacterial contaminants by removing portions of vegetables with a sterile knife and directly incubating these in cultural media.

Methods which utilize examination of vegetable washes are predicated on the assumption that the bacteria are easily removed from the vegetable surfaces. Those bacteria which are imbedded in cracks or injured parts of a vegetable can conceivably be untouched by these methods. The method of Mills might give more reliable results if the bacterial distribution on the vegetable surface were uniform. Quantitative estimates of bacterial concentration would be difficult.

To evaluate properly the bacterial concentration on a vegetable surface or a portion thereof, it was considered that the bacteria on the surface itself must be sought for several reasons.

1. The surface of field-grown vegetables may possess very tenaciously held organisms, which will not come off by simple washing, as was done by other workers.

2. Cracks and crevices in the surface or on injured parts may harbor bacteria and protect them from removal by rinses.

3. For studies on the decontamination of vegetables the bacteria remaining on the surface after a particular decontamination process is of chief interest.

For a quantitative evaluation of the bacteria remaining on a vegetable, it is necessary to divide that surface serially so that decimal dilutions can be examined in culture media.

It was considered that the use of a high-speed macerating machine such as the Waring blender could profitably be used as a means of finely dividing a vegetable or a portion of its surface with little danger of contamination from the outside. The blender, constructed of a heavy boro-silicate glass with a jar of about 300-ml. capacity with a wide mouth closed with a cover, permits steam sterilization in an autoclave. To use this machine it is necessary to determine the effect of high-speed maceration on bacteria and any deleterious effect of the macerated vegetables on the bacteria, thus influencing the counts obtained.

Effect of Maceration on E. coli

The Waring blender may have a deleterious effect on the bacteria, due to the rise in temperature of the macerate because of friction or mechanical breakdown of the bacterial cells by cavitation. Preliminary experiments showed that 100 ml. of water in a blender will rise approximately 8° C. from room temperature after 2 min. of operation.

To determine the effect of high-speed maceration on *E. coli*, a suspension of *E. coli* was prepared in sterile dilution water according to Standard Methods (8), and 0.00001 to 1 ml. bacterial suspension was added to 6 sterile blenders containing 99 ml. of sterile dilution water. Endo agar was used in evaluating the bacterial numbers. Each blender was operated at high speed. The machines were stopped at certain time intervals to remove 1 ml. of suspension for bacterial plate counts. Samples were taken before operation and 15, 30, 45, 60, 90, and 120 sec. after maceration had begun.

Table II shows the results of this test. The values given are calculated for comparison on the basis of the numbers of organisms per ml. of original bacterial suspension. Blender A initially contained 0.01 of this number per ml.; blender B, 0.001; etc. Maceration for 2 min. had no deleterious ef-

TABLE II.—Effect of Maceration on Varying Concentrations of *Escherichia coli*

Blender	Dilution of Original Suspension	Coliforms per Ml of Original Suspension ($\times 10^7$)						
		0 Sec.	15 Sec.	30 Sec.	45 Sec.	60 Sec.	90 Sec.	120 Sec.
A	10^{-3}	97	120	89	105	100	106	93
B	10^{-3}	100	110	90	100	120	110	90
C	10^{-4}	80	91	120	90	90	85	90
D	10^{-5}	85	90	90	82	96	83	80
E	10^{-6}	95	86	77	77	86	78	77
F	10^{-7}	91	93	70	72	88	100	75
	Average	91	98	89	88	97	94	84

fects on *E. coli* when its concentration ranged from approximately 100 to 10,000,000 per ml.

Sections of tomato skins were macerated and found to be finely divided after 1 min. In subsequent work this period of maceration was chosen, as it would insure against harm to the bacteria present, the temperature rise would not be significant, and reasonably fine division of the vegetables was obtained.

Effect of Macerated Tomatoes on E. coli *and* Salmonella

Though the actual process of maceration of a vegetable may have no deleterious effect on *E. coli*, it may not always be possible to transfer the macerate and subsequent dilutions immediately to culture media. Thus, the effect of the macerated vegetables on coliform organisms must be considered.

Tomatoes produce a fairly acid juice, which might be expected to have a deleterious effect on these bacteria. Anti-biotic substances, which may influence the survival of bacteria in a vegetable macerate, have also been isolated from vegetables.

The following experiment was devised to show whether there is a time limit within which the macerated vegetable must be examined culturally for bacteria.

Tomatoes were macerated in a Waring blender and the volume made up to 600 ml.; 200 ml. of macerate was added to each of two sterile blenders. To one, sufficient 0.1 *N* NaOH (39 ml.) was added to neutralize to about pH 7 (previously determined potentiometrically on a separate 100-ml. portion); to the other, an equal volume of sterile dilution water. To a third sterile blender, 239 ml. of sterile dilution water was added. A 1-ml. suspension of *E. coli* prepared from a 24-hr. agar slant was added to each of the blenders. Each was macerated for 15 sec., and samples were taken from each at intervals of 0, 1, 3, 5, 10, 15, 30 and 60 min. after maceration for enumeration of *E. coli* on Endo agar.

The results obtained (Table III) show that the variation of coliforms per ml. of macerate ranged from 2,100,000 to 3,000,000 in the juices.

TABLE III.—Effect of Macerated Tomatoes on *Escherichia coli*

Macerate....	Tomato	Tomato	Dilution Water
pH.....	4.5	6.6	7.2
Time after Maceration (min.)	Coliforms per Ml. of Macerate $\times 10^6$		
0	20	28	24
1	26	21	–
3	24	25	–
5	30	27	21
10	24	25	22
15	23	27	–
30	25	27	17
60	23	27	26
Average	24	26	22

The difference in the pH values (4.5 and 6.6) apparently had little effect up to 1 hr. after maceration ceased. The average values for the two juices were essentially similar.

An experiment was conducted with *Salmonella cerro* to check the effect of the tomato juice at varying concentrations on this organism and to see whether the medium used was altered so that abnormal, uncharacteristic colonies were produced. The results were:

Tomato Juice Concentration	*Salmonella* per ml. × 10^8
Control (no juice)	2.3
1:1,000	0.8
1:100	1.2
1:10	2.0

It was concluded that tomato juice has neither an inhibitory effect on the bacteria nor a detrimental effect on the medium during the time required for the experiments.

On the basis of these experiments it was concluded that the Waring blender could be used for the evaluation of the bacterial concentration of vegetables without harm to the bacteria because of either the action of the rotating blades or the properties of the macerated vegetables.

Expression of Results

In subsequent work on the coliform evaluation of whole tomatoes, the results are expressed on the basis of the number of organisms per gram of tomato, as the weight of the fruit is an easily determined quantity. As has previously been pointed out, the organisms found will be on the surface, because the interior of normal healthy fruit is sterile. A better method of expression would be numbers of organisms per square centimeter of surface, but the surface area is a difficult quantity to determine because of variations in shape of the fruit.

If one assumes that a tomato is a perfect sphere, its volume would be expressed as

$$V = \tfrac{4}{3}\pi r^3$$

where V is the volume and r the radius. The surface area, S, would be given by

$$S = 4\pi r^2$$

As the density of a tomato is practically unity, its weight, W, in grams, would be equal to its volume, V, in cubic centimeters. Solving the above two equations for S gives

$$S = 4.84\pi W^{2/3}$$

Plotting S, in sq. cm., against W in grams, one obtains a straight line on log paper. The characteristic of this line is such that W is numerically equal to S when a tomato weighs about 110 g. The following tabulation shows the relationship for other tomato weights:

Weight (g.)	Surface Area (sq. cm.)
50	66
100	105
150	137
200	163
250	190
300	215

Most tomatoes weigh between 50 and 150 g. Thus, it can be assumed that coliform organisms per gram can be considered equal to the number per square centimeter, as the inaccuracy of determination of coliform organisms by the multiple-tube dilution technique is greater than the inaccuracy of this assumption.

Bacterial Contamination of Tomatoes Grown in Polluted Soil or Receiving Direct Pollution

Examination of the published literature has revealed little direct evidence of extensive transmission of bacterial enteric diseases by consumption of raw nightsoil-fertilized vegetables. The role of polluted vegetables in areas where such diseases are endemic or epidemic is difficult to separate from the influences of polluted drinking water, insect vectors, or food handlers.

In an effort to evaluate some of the

factors which may influence the pollution of vegetables grown in soil fertilized with human sewage and to indicate the possible sanitary quality of such foods for raw consumption, certain field tests were carried out. These experiments were performed by growing crops on a sewage irrigation farm and on an ordinary farm where the vegetables received direct applications of human excrement or suspensions of coliform organisms. Tests were run on the resultant harvest for coliform contamination.

Methods of Study

Sewage Irrigation Farm

Field experiments were carried out at the sewage irrigation farm at the New Jersey School for Girls, Vineland, N. J. Normal practice at this farm is to utilize the settled institutional sewage for the irrigation of fodder corn and never on crops for human consumption. The soil is of a somewhat sandy nature and can absord considerable quantities of water.

A small portion of this farm was set aside for these experiments. The arrangement of the experimental plot is shown in Figure 1. Settled sewage is led to the field by means of a buried pipe, in which outlets are spaced at 14-ft. intervals. Areas A and B had been flooded with sewage several times during the spring of the year (1948) in which these experiments were carried out. This occurred before tomato planting. Area C had never received sewage.

Tomato plants were set in these areas in rows 7 ft. apart at intervals of 5 ft. The soil in area A received sewage irrigation during the entire

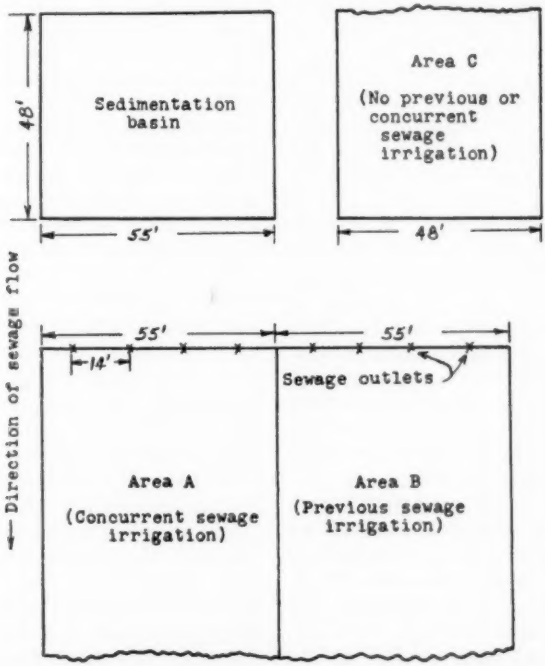

FIGURE 1.—Plan of experimental plots on sewage farm, Vineland, N. J.

growing season to the extent of the ability of the soil to assimilate it and within the bounds of good farming practice. The manner of irrigation consisted of allowing the sewage to flow down between the rows as near to the plants as possible. Splashing of sewage on the fruit and plant was then possible during heavy rains.

Area B received no further sewage after the plants were set. Area C, as indicated above, had never received sewage, and none was permitted to enter during the experimental study. Normal farming practices with respect to cultivation and plant disease control were carried out.

Certain plants in each area were staked so that fruit growing far from the ground could be obtained. Others in areas A and B were grown with a layer of a nontoxic waterproofed paper between the plant and the soil. This was done to prevent, as far as possible, direct splashing of soil and pollution on the fruit by rain.

The fruit was harvested by cutting the stem with scissors and allowing the fruit to drop into a heat-sterilized paper bag. For each tomato, the following information was recorded: (a) the plant on which it grew, (b) its height from the ground, (c) its state of ripeness, (d) the presence of cracks or crevices in and about the stem and blossom ends, (e) the shading of the fruit by leaves and other fruit. Shading was classified roughly as completely exposed to the sun, completely shaded from the sun throughout the day, and partly shaded for some time of the day (such as might occur when the sun was near the zenith).

Samples were collected weekly from July 22 to September 7, and each tomato was assayed for the numbers of coliform organisms. The tomatoes were stored overnight in a cold room at a temperature of 8° to 10° C.

Each tomato was weighed to the nearest gram while in the sterile paper bags, the bags were opened and the tomatoes transferred to sterile blenders, and sufficient sterile water was added to bring the total weight to the nearest even 100 g.

Field Experiments at N. J. Agricultural Experiment Station

Field experiments with coliforms as index organisms were designed to show the fate of fecal coliform organisms present on tomatoes that received direct applications of feces or *E. coli* suspensions. On a farm of the N. J. Agricultural Experiment Station 40 plants were set out in two rows approximately 6 ft. apart, at 5-ft. intervals, 20 plants per row. Feces suspensions were prepared by macerating about 25 g. of fresh feces with 200 ml. of tap water in a Waring blender, centrifuging, and diluting the supernatant to 1 l. *E. coli* suspensions were prepared from agar slants 24 to 48 hr. old. The culture was washed from the slant and diluted with water. The tomatoes and flowers on the plants were sprayed directly with these suspensions, which then dried on the surface. A total of 5 sprays was applied at about two-week intervals. The fruits were harvested and assayed aseptically in the same manner as those from the sewage irrigation farm.

The experiments with *Salmonella* and *Shigella* species were similar in scope to the tests described above, but were conducted with cultures of *Salmonella cerro* and *Shigella alkalescens*. These tests were carried out both in 1948 and in 1949. Field survival tests were supplemented by laboratory tests on vegetable surfaces.

The general experimental procedure consisted of spraying tomatoes in the field or laboratory with a suspension of bacteria alone or mixed with feces suspensions. At intervals of a few days, tomatoes were sampled and assayed for the organism under study.

Results of Field Experimentation

Climatological Data

The rainfall and average atmospheric temperatures for the areas in which these experiments were carried out were obtained from U. S. Weather Bureau climatological data.

As a whole, the precipitation from May through August, 1948, was above average except during July at New Brunswick and June at Vineland. Both stations received the greatest amount of rain during August, when the precipitation in Vineland was more than twice the normal amount. During these four months, measurable rain fell on 48 out of 120 days, an average of a little more than once every 3 days. Precipitation was below normal during September and October, when rain fell on 11 out of 60 days, or about once every 6 days. Temperature data indicate no particular abnormalities. The highest average temperatures, as well as average maximum and minimum temperatures, were found in July. The highest individual temperatures of the season, however, were obtained during August, when recordings of about 100° F. were made. The lowest temperatures were recorded during October when frost occurred.

Similar climatological data for 1949 show that the early summer was characterized by above normal temperatures and below normal rainfall from June through August.

Sewage Irrigation Farm

Tomatoes harvested from the field were found, generally, to be of two types: those which presented normal-appearing stem ends, and those which had these ends cracked or split. The latter appeared to form early during the rainy periods. On the assumption that these cracks and crevices might easily harbor bacteria, the data from these experiments were grouped according to normal and abnormal cracked stem ends. In addition, the data have been grouped according to the height of the fruit from the ground and by the degree of shading from the sun.

1. *Relation of Tomato Contamination to Height above Ground.*—In Table IV are summarized the data obtained on the coliform contamination of the tomatoes grown on the Vineland sewage irrigation farm. The average values calculated for these results are based on the median rather than the arithmetical average, as variations are of such a wide range that the latter average would not be expected to yield a satisfactory expression of the results.

The over-all medians of contamination of normal tomatoes from areas A, B, and C do not differ materially, averaging 8 to 10 coliforms per gram of tomato. However, individual tomatoes in all three areas may have anywhere from less than 1 to more than 50,000 organisms per gram. Only on the normal tomatoes from area A was the effect of the height of the fruit from the ground clear cut. These show an average of 110 coliforms per gram of tomato in contact with the ground, as against 7 to 10 for those raised from the soil. Apparently, the actual distance from the ground has little influence on the contamination. In this connection, comparison of the results obtained for the coliform contamination of the fruit in areas A and B, which were protected from splashing of the soil and pollution by rain by the use of a waterproof paper covering between the plant and the ground, shows no difference between protected and unprotected plants. It appears that other factors than direct splashing of the soil to the plant by rain are important in the contamination of the fruit.

The over-all median contamination of the tomatoes with abnormal stem ends was higher in area A, where pollution was continuously applied, than in areas B and C, which were about

TABLE IV.—Summarized Data of Median Coliform Contamination of Tomatoes From Areas A, B, and C

Area	Distance from Ground (in.)	Stem End	Number of Tomatoes Tested	Coliforms per Gram	
				Median	Range
A	0	Normal	11	110	1 to 45,000
	1–5		14	7	1 to 50,000
	6–10		6	9	1 to 720
	11–34		8	10	1 to 330
	Over-all		39	9	
A	0	Abnormal	3	16,000	7 to 37,000
	1–5		15	150	1 to 36,000
	6–10		8	25	3 to 190
	11–20		7	150	4 to 7,500
	Over-all		33	120	
B	0	Normal	8	3	1 to 300
	1–5		19	7	1 to 36,000
	6–10		5	105	1 to 730
	11–30		10	30	1 to 730
	Over-all		42	8	
B	0	Abnormal	4	32 to 28,000	2 to 45,000
	1–5		9	8	1 to 46,000
	6–10		6	75	38 to 1,100
	11–16		6	3 to 4,100	1 to 40,000
	Over-all		25	40	
C	0	Normal	6	6 to 27	1 to 50
	1–5		8	1	1 to 60
	6–10		6	6 to 200	1 to 530
	11–26		10	17	1 to 8,400
	Over-all		30	10	
C	0	Abnormal	6	200 to 500	4 to 37,000
	1–5		9	2	1 to 1,000
	6–10		5	40	1 to 42,000
	11–21		7	130	13 to 24,000
	Over-all		27	44	

equal. The median value for area A contamination was 120 coliforms per gram of tomato; those in areas B and C were 40 and 44, respectively. The abnormal stem ends were characterized by splits or grooves radiating from the stem. These provided excellent harboring places for microorganisms, which would be protected from drying out. Here again, no significant variation of contamination with height could be detected. The ranges of values were as great as among the normal tomatoes.

2. *Relation of Tomato Contamination to Exposure to Sun.*—Normal tomatoes from area A showed decreasing contamination with increasing exposure to the sun. In the other two areas there was also a tendency toward lower contamination when the fruit ripened while exposed. The reduction was not

apparent in completely shaded or semiexposed fruit in these latter areas.

Examination of the tomatoes with abnormal stem ends showed no apparent relationship between the degree of contamination and exposure to the sun. Apparently the bacteria in the cracks and crevices were protected from the action of the light.

Field Experiments at N. J. Agricultural Experiment Station

In the coliform experiments at the N. J. Agricultural Experiment Station the tomatoes were sprayed with suspensions of *E. coli* or fresh feces. Sampling began 11 days after the last spraying. The results of coliform counts of these tomatoes are summarized in Table V. The median coliform count of the normal control tomatoes was 5 per gram of tomato, and that of tomatoes with cracks about the stem end was 250 per gram. Detail data show no trend toward a reduction of the coliform count on either group during the monthly period in which samples were taken after spraying had ceased. Examination of Table V with respect to tomatoes contaminated by feces and *E. coli* shows the median coliform counts to be high 11 days after spraying had been stopped. These values, however, had decreased to those of the control or even lower after 35 days. It is interesting to note that the range of values obtained for the coliform contamination also decreased with time.

TABLE V.—Coliform Contamination of Tomatoes Sprayed with *E. coli* or Feces

Contaminant	Time After Spraying Ceased (days)	No. of Tomatoes Tested	Coliforms per Gram of Tomato	
			Median	Range
(a) Tomatoes with Normal Stem Ends				
Unsprayed	11 to 42	13	5	1 to 1,200
Feces	11	19	800	1 to 64,000
	35	8	1	1 to 200
	42	7	1	1 to —
E. coli	11	4	2,000	1 to 4,000
	35	9	3	1 to 800
	42	7	4	1 to 70
(b) Tomatoes with Abnormal Stem Ends				
Unsprayed	11 to 42	12	250	1 to 48,000
Feces	11	4	1,000	380 to 41,000
	35	6	5	1 to 70
	42	5	1	1 to 27
E. coli	11	6	12,000	7 to 33,000
	35	4	200	1 to 33,000
	42	5	1	1 to 1,100

The 1948 and 1949 summarized results of the field experiments with *Salmonella cerro* for survival on tomato surfaces are shown in Table VI.

TABLE VI.—Median *Salmonella cerro* Survival on Tomatoes in the Field, 1948 and 1949

Season	Exposure (days)	*Salmonella* per Gram
1948	5	0[1]
	7	0
	14	0
	27	0
1949	1	6,000
	3	15
	4	0[1]

[1] One tomato contaminated.

Climatologically, the two periods were somewhat different. During the 1948 tests, the weather was fairly clear with a gradual drop in temperature. Rainfall was considerably below normal. The first frost of the season occurred the night before the last samples were taken. In 1949, the first three days were partly cloudy and rain occurred before the last sample was taken. In the 1949 test, all tomatoes selected were shaded by leaves and other vegetables so that sunlight would be of minimum importance. Nevertheless, the assays showed that the *Salmonella* died out rapidly under field conditions even without exposure to sunlight. By the fourth day only one tomato was still contaminated in the 1949 test.

It was considered of interest to compare the survival of *Salmonella* on the surface of tomatoes kept in the laboratory with that in the field. Fifty-three tomatoes were sprayed with a suspension of *Salmonella cerro* and

kept at room temperature in the laboratory. They were protected from flies by netting stretched over but not touching the fruit. Samples of 4 or 5 tomatoes were assayed at intervals. Inability to keep the fruit at room temperature without spoilage prevented a test duration of longer than 20 days.

The results are shown in Table VII. In spite of the relatively long period of the test, the survival time of the bacteria was not exceeded. This is in sharp contrast with the results obtained in the field, where survival did not extend beyond 7 days.

TABLE VII.—*Salmonella cerro* Survival on Tomatoes in the Laboratory

Exposure (days)	Tomatoes Tested	*Salmonella* Remaining per Gram	
		Median	Range
0	5	180	30 to 230
1	5	72	24 to 1,100
2	5	410	22 to 102,000
4	5	5,300	350 to 20,000
5	5	90	27 to 780
6	5	20	2 to 440
7	5	2,100	14 to 22,000
9	4	1,700	0 to 2,800
12	5	1,200	140 to 6,700
15	5	190	0 to 14,000
20	4	100	0 to 9,500

In the laboratory no trend toward a significant decrease in numbers was found. The numbers of viable bacteria remaining fluctuated widely. These fluctuations were probably due to wide variation in the initial contamination.

The longevity of *Shigella alkalescens* on the surfaces of tomatoes in the field was found to be similar to that of *Salmonella*. The summarized data for the survival of *S. alkalescens* on tomatoes in the field (Tables VIII and IX) show the results when a suspension of the organisms alone was used and when a suspension in feces was used. To minimize the deleterious effect of sunshine, the sprayed tomatoes were as nearly completely shaded as possible.

TABLE VIII.—Survival of *Shigella alkalescens* Applied in Suspension Alone to Tomatoes in the Field (Median Values)

Series	Exposure (days)	*Shigella* per Gram
A	0	720
	1	450
	3	0
B	1	40,000
	3	20,000
	4	190

During series A the weather was characterized by high temperatures and low rainfall. After three days, the *Shigella* had disappeared from the tomatoes. The results of series B, which was conducted during a period of cooler, cloudier, and wetter weather, showed a slower reduction of *Shigella*. Not all had disappeared in 4 days, although 60 per cent of the fruits were free of the organism.

When *S. alkalescens* was sprayed on the tomatoes as a feces suspension, counts were also made for *E. coli* and *A. aerogenes*. These three organisms could be differentiated fairly well on the desoxycholate agar used. Some of the coliform counts were verified by parallel plating of the samples on eosin-methylene blue agar. Fairly good checks were obtained with the E. M. B. agar, indicating that the results obtained on the primary desoxycholate medium were reliable.

The *Shigella* disappeared rather quickly. It could not be recovered on the second day after spraying. *E. coli*

TABLE IX.—Survival of *Shigella alkalescens* Applied in a Feces Suspension to Tomatoes in the Field (Median Values in Numbers Per Gram)

Exposure (days)	*E. coli*	*A. aerogenes*	*S. alkalescens*
0	1,380	4,400	370,000
1	3,400	5,000	10,000
2	110	[1]	0
6	25	70	0

[1] Erratic results.

and *A. aerogenes* decreased less rapidly, but had not disappeared after 6 days. This is in essential agreement with the previously described field results on coliform organisms, where they were reduced to a relatively small residual number and never completely disappeared.

Discussion

The number of coliform organisms on the surface of a vegetable can be considered as the result of an equilibrium between those being deposited from the soil and those being removed or being killed. At any given time the environmental conditions will determine the magnitude of this equilibrium value. The characteristics of the surface of the vegetable will influence the speed of death. A surface which can harbor or protect the organisms from removal will increase this equilibrium value. If the number of pollutional organisms present is increased by the addition of contamination either to the soil or directly to the vegetables, an increase in the resultant equilibrium values can be expected, because the rate of deposition of coliform organisms would be increased. Should the added pollutional organisms be less viable, less resistant under field conditions, then the rate of destruction would also be expected to increase.

If vegetables grown in a pollutional environment show no higher coliform contamination than those grown under similar conditions but in the absence of such pollution, it may be assumed that the coliform organisms from the source of pollution had been killed. Inasmuch as intestinal coliform organisms are more resistant to external environmental conditions than enteric pathogenic bacteria, these latter would also be expected to have been destroyed.

Thousands of tons of vegetables, including their skins, are eaten raw every year in this country. On the basis of the values for the control tomatoes in the field experiments, it is evident that the consumption of coliform organisms must take place in large numbers from field-grown vegetables of the salad type. Yet, epidemiologically, the consumption of raw fruit has not been definitely shown to cause directly even small outbreaks of intestinal bacterial diseases. Although vegetables are grown in a pollutional environment, if they show no higher bacterial contamination than those grown in a similar unpolluted environment, they will be no more of a danger to public health than those grown on normally farmed areas.

The experimentation was designed to evaluate and compare the extent of the coliform contamination on tomatoes grown in a polluted environment and in a similar but uncontaminated environment. The pollution consisted either of furrow irrigation or direct application of feces suspensions to the fruit, which may represent spray types of irrigation or direct applications of nightsoil as is frequently practiced. In addition, the survival of pathogenic types, such as *Salmonella* and *Shigella* species, was investigated to supplement with direct evidence the findings with the coliform organisms.

The condition of a vegetable is apparently important in determining the average coliform concentration on its surface. Regardless of whether the fruit was grown on soil being irrigated during the growing season, on soil which had received previous but not concurrent sewage irrigation, or on soil which had never received sewage irrigation, the tomatoes with normal stem ends showed lower average contamination than those with stem ends characterized by splits, cracks, and crevices developed during growth. These areas act as harboring places for the contaminating bacteria. A similar relationship can be found for those tomatoes which had received direct applications of feces or *E. coli* sprays, or had grown without contamination. It

would appear that the previous pollutional history of this soil had little effect on the resultant coliform contaminations of tomato crops taken from it. Even when pollution was concurrent, only in the case of tomatoes with abnormal stem ends was the contamination higher than for control tomatoes. Since such tomato portions are not particularly appetizing, it is likely that they would be cut away before consumption.

Direct splashing of contaminants upon the fruit from the soil by rain has been considered one of the more likely means of contamination of a vegetable of the tomato type, as the fruit itself develops above the ground. If rain splash were important, the contamination would be expected to decrease rapidly with the height of the fruit above the ground. Results show that there is little to indicate any relationship between the height of the fruit and its surface coliform concentration. Average contamination of the fruit in actual contact with the soil was higher in some cases, but these were likely to carry gross visible particles of dirt, which could account for these higher numbers. Such visible dirt would normally be removed before consumption.

If splashing were important in the contamination of these tomatoes, it would be expected that a protective covering between the soil and the plant would produce fruit of considerably lower contamination than when this covering was absent. When such conditions of growth were employed, this was not found to be the case.

It is apparent that although splashing is one of the factors responsible for carrying contamination from the ground to the fruit, others are of combined greater importance. Among those which can be enumerated are the dirt carried by the wind and deposited on plant surfaces, the soil carried to portions of the plant by the movements of insects, and the dirt raised during cultivation of the crops.

Sunlight is considered to have a destructive effect on intestinal bacteria as a result of desiccation, heating, and the action of light of certain wave lengths. Any action which increases the death rate of vegetable contaminants without increasing the rate at which the bacteria reach the surface will decrease the average surface coliform concentration, hence surface contaminants would be less when the tomatoes were exposed to the sun than when shaded. Exposed normal tomatoes showed consistently average lower coliform concentrations than those which were completely or partly shaded. Abnormal tomatoes, on the other hand, showed no consistent relationship between coliform concentration and shading. It appears that these tomatoes were able to protect the bacteria, in the cracks and crevices, from drying, excessive heating, and/or the lethal action of ultraviolet wave lengths.

The direct spraying of feces or *E. coli* suspensions upon the surfaces of growing tomatoes was taken as comparable to the contamination which vegetables might receive when night-soil was applied directly to the plants. On the basis of the criterion that the consumption of such sprayed plants would be no more dangerous bacteriologically than consumption of the controls when both attained the same average coliform concentration, it would appear that these tomatoes would be safe by the 35th day after spraying had ceased. It must be borne in mind, however, that these statements apply only to enteric bacteriological contamination.

Although the abnormal tomatoes show higher coliform contamination after 35 days than do the normal tomatoes, the counts on the sprayed fruit are not higher. Apparently, the coliform contaminants added during spraying could not survive the conditions of the field with variations in temperature, moisture, and the action of sunlight. This confirms the results dis-

cussed above when dealing with sewage irrigated crops of the tomato type.

When the coliform concentrations are used as a yardstick, it appears that tomatoes sprayed with polluting material would be bacteriologically safe for consumption after about a month. This length of time gives a comparatively broad margin of safety, as can be seen from the results of the field experimentation on the survival of *Salmonella* and *Shigella* types. These organisms apparently were completely killed by exposures of a week at the most. They were more sensitive to the external environmental conditions and changes than the coliform organisms under similar conditions.

The experiments described were carried out in a temperate climate. In tropical regions, higher humidity conditions may increase the survival of bacterial contaminants on vegetable surfaces. On the other hand, higher tropical temperatures would tend to decrease bacterial survival. However, the relative humidity within the extremely thin layer next to the vegetable surface in which bacteria are attached would probably be near saturation. Furthermore, transpiration would tend to keep the temperature from exceeding values detrimental to the plant. For this reason, it is quite likely that the environment of the adhering bacteria on the vegetable surface may be fairly independent of the environment of the plant as a whole, hence survival in the tropical regions might be very different from that in temperate or drier regions. Further experimentation along similar lines in tropical regions would be desirable to complete the picture.

Conclusions

On the basis of field experiments on the growth of tomatoes in a pollutional environment the following conclusions were drawn:

1. When tomato surfaces are badly split or marked by cracks, the over-all coliform concentration will be higher than when tomatoes are normal. Such cracks and crevices apparently offer harboring places, which protect the contaminants from the rigorous external field conditions. Ordinarily, these portions of tomatoes would be cut away before consumption.

2. Little evidence could be found of a relationship of the coliform concentration to the height of the fruit above the ground. Fruit in actual contact with the soil frequently showed higher coliform counts, but gross soil particles adhering to the fruit could account for these values.

3. The splashing of the soil upon the fruit during rain is apparently not an important factor in carrying contamination to the fruit above the ground. Additional vectors are wind-driven dust, insect movements, and soil cultivators.

4. Complete exposure of tomatoes to the sun results in lower coliform concentrations on the surfaces of normal fruit. Abnormal tomatoes with split stem ends provide protection and aid survival of the organisms.

5. Of tomatoes grown on a sewage irrigated farm, only those with abnormal cracked stem ends showed an average higher surface coliform concentration when irrigated simultaneously with sewage, as compared with those grown on soil which had received sewage irrigation only before planting or on soil which had never received sewage. Normal tomatoes showed no difference, on the average, regardless of the type of pollution.

6. When feces or *E. coli* suspensions are applied directly to the surfaces of growing tomatoes, the residual coliform concentration decreases to or below that of uncontaminated controls by the end of 35 days. This time may be considerably shorter. However, if fecal material is applied directly to growing tomatoes, such applications should be stopped about one month before harvest begins. This procedure

will decrease to almost *nil* the chances for the transmission of enteric bacterial diseases through the vector of such raw fruit.

7. The survival of representatives of the *Salmonella* and *Shigella* genera on tomato surfaces in the field did not exceed seven days, even when the organisms were applied with fecal organic material, which might have offered some protection. Thus, cessation of the application of fecal fertilizing materials to crops one month before harvest will offer a considerable margin of safety for protection against enteric bacterial diseases even though the vegetables are consumed raw.

Summary

Field experiments during two growing seasons were designed to evaluate and compare the extent of coliform contamination of tomatoes in a similar but uncontaminated environment. The pollution consisted of either furrow irrigation with settled sewage normally used for the purpose, or direct application of feces suspensions to the fruit and leaves, which may represent spray types of irrigation or direct applications of nightsoil as frequently practiced. In addition, the survival of pathogenic types, such as *Salmonella* and *Shigella* species, was investigated to supplement with direct evidence the findings with coliform organisms.

The results show that if sewage irrigation or nightsoil application is stopped one month before harvest, the fruit, if eaten raw, would not be likely vectors for the transmission of human bacterial enteric diseases.

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JULY, 1950, JOURNALS WANTED

Due to the large number of new memberships and subscriptions received after the issue was printed, the supply of July, 1950, Journals has become depleted. As a consequence this issue cannot be supplied to members whose names were added to the list late in the year. Some of the files affected are of extreme importance to research or regulatory agencies in foreign countries.

Contributions of the July, 1950, issue of the Journal will be welcomed and should be sent collect to the Federation of Sewage and Industrial Wastes Associations, 325 Illinois Building, Champaign, Ill.

MEASUREMENT OF SEWAGE FLOWS*

By Walter H. Brown

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Complete and accurate metering is essential for maximum operating efficiency and minimum cost of operation of any sewage treatment process. This paper endeavors to present:

1. The chief points in a sewage treatment plant where flow measurements are desirable.
2. A brief discussion of types of applicable metering devices.

Under the first topic are included such items as:

1. The raw sewage, or plant influent.
2. The primary sludge.
3. The primary effluent, or settled sewage.
4. The returned sludge (to filters or aeration tanks).
5. The excess or waste activated sludge.
6. The digested sludge.
7. The air to each aeration tank.
8. The gas from digesters.
9. The elutriation water and elutriated sludge (if vacuum filters are used).
10. The filter cake.

Plant Influent

In all treatment processes, it is practically a "must" to know the plant influent rate and the total quantity involved. This measurement is usually made after screening or comminution and grit removal. The three most widely used metering units for this point are the Venturi tube, the Parshall flume, and the Kennison open nozzle. Each has its advantages and disadvantages.

Usually, the loss of head through a sewage plant must, of necessity, be held to a minimum. Therefore, the loss of head through any metering device is of prime importance. Of the three types under consideration, the Venturi tube produces the least drop. The Parshall flume generally requires a slightly greater head than the Venturi. The loss through the Kennison nozzle is the greatest, as a free discharge is essential.

For accuracy and dependability, the Venturi meter, if carefully selected as to size and type, is preferable. In general, the accuracy of a Venturi is within plus or minus 2 per cent over a range of flow of 15 to 1. The Kennison nozzle is an excellent performer. Being constructed in the shop, its error can be within plus or minus 2 per cent. Low cost is a consideration in the Parshall flume, which may be well suited for the larger installations. However, its accuracy is dependent on the skill of the workmen engaged to construct it. It should also be noted that the flume, if there is more than 70 per cent "submergence," must have a correction factor applied: this is rarely practicable in a sewage plant.

The Venturi tube should have as large a throat as possible (particularly for sludge), consistent with metering accuracy, thus holding to a minimum the possibility of clogging. Both the flume and the nozzle, being of the open type, are more readily cleaned.

Weirs and orifice plates usually are not desirable due to their susceptibil-

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ity to partial clogging or the building up of solids around them.

With regard to cost, these primary devices rate in the same order as for accuracy, the tube being the most costly and the flume the least, although closely pressed by the nozzle.

At Cranston, R. I., a 24 × 13.281-in. Venturi tube, producing a 60-in. differential, is used to handle a peak flow of 12 m.g.d. This tube is located in a pipeline about 10 ft. below the water line in the following grease aerator, and between that unit and the preceding comminutor and grit chamber. This tube is equipped with air relays and continuous clear-water flushing back through small orifices.

In eight years of operation, no trouble of any kind was experienced with this set-up. During that period, there was less than 4 qt. of mud removed from the relays and the tube. The air relays transmit the differential through ¼-in. copper tubing approximately 150 ft. long to a totalizing, indicating, and recording instrument located in the control room. Such tubing should be run to avoid trap points and should be provided with condensate drains.

Primary Sludge

For the measurement of primary sludge, a Venturi tube is about the only device that will give accurate and dependable service. At Cranston, the primary sludge tube is equipped with a pressure chamber, hand vent cleaners, a flush check system with Sight-flo indicators, and air relays. The success of this type installation is easily seen by the fact that in eight years only clean water ever came out of the water chamber of the air relays.

Richardson, in describing a volumetric check of the accuracy of this tube, reported an error of less than 1 per cent over a course of 12 weeks. The sludge during this check averaged approximately 6.50 per cent dry solids. Air relays were installed on this tube before the flush check system was developed. The air relays were used so that ¼-in. copper tubing could be used to transmit the differential pressures some 50 ft. to the wells of the totalizer-indicator-recorder without the possibility of clogging by the solids content of the sludge. Events later showed that only the flush check system is necessary and that it is amply sufficient to keep solids out of the pressure lines. Orifice plates are not recommended for sludge lines.

Settled Sewage

Settled sewage measurement is a relatively simple problem to solve. As most objects which tend to clog or interfere are removed, either a Venturi, orifice-plate, weir, or in some instances, a Parshall flume or Kennison nozzle can be used. If other than a Venturi is used, care must be taken that the velocity of flow is great enough to scour, otherwise a slime build-up might eventually reduce the efficiency of the device. The Providence, R. I., sewage treatment plant probably has the largest Parshall flume measuring sewage on record, the throat being 10 ft. in width.

Return and Excess Sludge

In an activated sludge plant, it is quite necessary to meter returned sludge (the activated sludge which has settled out in the final settling tank and is being returned to the influent end of the aeration tank), and excess or waste activated sludge (that which is not necessary to return to the aeration tank or, by rule of thumb, about 10 per cent of the returned sludge). The best all-around device for this is the Venturi tube. The solids content of this sludge is low (around 2 per cent) and the particle size small and uniform.

Digested Sludge

Digested sludge, as drawn by gravity from the digestion tanks, usually presents a problem. The sludge is or should be heavy, averaging 8 to 10 per cent solids, and viscous. Unlike primary sludge, there is a definite skin action and the center core may readily be observed as moving more rapidly than the outer layers. This phenomenon tends to affect seriously the accuracy of the plain Venturi tube. However, by use of the flush check system enough water is injected around the throat of the tube to act as a lubricant, thus minimizing this effect. Good results are then possible. If there is sufficient elevation available, a Kennison nozzle discharging into an open tank is a good device. Some engineers prefer to draw the digested sludge into a tank of known volume.

Air Volume

In any plant where air is used in the process, it is usually vital to know the amount, or at least the rate, of application. The pumping of air is a costly procedure. Power charges are high, even though gas engines may be all or partially operated by the plant's own digester gas. Thus, the usual design provides for as small a head loss as possible. This means first a Venturi tube, or secondly, an orifice plate, must be used to meter the air. However, neither of these can be very accurate if the blower providing the air is of the pulsating type without an adequate receiver (usually impracticable on account of the large size required) to damp out or minimize such pulsations.

At Cranston, Venturi tubes were used on the discharge lines from positive displacement-type blowers. As an added precaution, these tubes were placed as far away from the blowers as possible. The result was a steady thin line on the air volume meter. The installation at Cranston was, for all practical purposes, the exception that proved the rule. Usually, positive displacement-type blowers are very troublesome so far as metering is concerned. The pulsations, even though occurring at a high frequency, cause appreciable errors.

The fact that a "Chronoflo" meter was used for this instead of a "Flowatch" brings up an interesting point. Chronoflo instruments were used on the air, returned sludge, and settled sewage lines. The rates as indicated by these meters were, in one instance, transmitted to a ratio gage, which showed visually the ratio between air and settled sewage; in the other, between returned sludge and settled sewage. This was very helpful in the actual operation of the activated sludge process. By providing remote-controlled vari-drive pumping units, the operator was able to regulate the noted ratios from the control board in the operating room and so maintain definite predetermined relations between the various components used in the proper conditioning of the mixed liquor.

Gas Measurement

In plants where sludge is digested, gas is produced. There is then the opportunity to make use of this gas and so obtain some benefit out of an otherwise expensive process. Whether this gas be used in heating units, gas engines, or incineration, the knowledge of the quantity used and the rate at which it was used is of importance.

There are several types of meters available for this service. Perhaps the most commonly used and most satisfactory is the displacement-type meter, suitable for very small flows as well as flows reaching several hundred thousand cubic feet per hour. The head loss is low, ranging from a fraction of an inch to around 2 in. of water. The line pressure may range from practically zero to several hun-

dred pounds. In passing it might be mentioned that orifice plates, ring balance units, and other types have been used very satisfactorily when flow and pressure conditions have favored their use. Regardless of the type of metering device used, condensate traps should be provided in order that as much moisture as possible be eliminated from the gas. Thus, accuracy and life of the unit in question will be measurably preserved.

Elutriation Flows

In plants where elutriation of sludge is practiced, it is desirable to know the ratio between plant water and the digested sludge. This means either an indicating, recording, or combined indicating-recording water meter. There are many types and styles of such meters available. The displacement type, monometer, Venturi, and propellor type are a few such devices. About the only considerations are to be sure that the meter is of sufficient capacity and constructed of materials resistant to any possible corrosive qualities which the water may have.

Filter Cake

More and more plants are now filtering their primary, digested, excess activated, or combined sludges. The filtration process itself requires very careful control. If this control is not good, many of the plant's dollars will be wasted and not be available for other useful purposes. One relatively inexpensive device which is quite desirable in this connection, is the conveyor scale to indicate and record the actual weight of filter cake produced. The "Conveyoflo" meter has been found to be ideal for this application. It is a simple, rugged, and dependable unit. It is accurate within 2 per cent from 10 to 100 per cent of its capacity. It uses an air transmission system, which not only weighs the belt and cake being run over it, but it automatically subtracts the weight of the return belt plus any material adhered or soaked into it. Thus, a true picture of the actual filter cake produced is obtained.

Secondary instruments are sometimes desired and rate of flow indicators, recorders, or indicator-recorders may be located near the scale or remotely placed for convenience.

Conclusions

This paper has been a general informative discussion of various metering devices used in connection with the treatment of sewage. No attempt has been made to go into actual design problems and computations. To do so would require many hours; however, some general conclusions may be drawn.

Complete metering is essential to efficient plant operation. No operator of any process can do justice to it unless he knows the conditions under which it is being operated. This applies to laboratory analyses, as well as flow. It is essential to know, and not to guess, the performance of each main unit in any large-scale reduction process as complete as sewage treatment. There are several types of meters usually available for any given measurement of flow in a sewage plant. The selection of these must be carefully made, after taking into consideration all the conditions involved. A good consultant is invaluable in this connection.

The cost of metering is usually a very small percentage of the total amount spent for the treatment plant. This money in most cases, can be saved many times over through the more efficient operation of the plant, especially with regard to pumping, power, chemical, and heating requirements.

DISINFECTION OF SEWAGE WITH CHLORINE*

IV. AFTERGROWTH OF COLIFORM ORGANISMS IN STREAMS RECEIVING CHLORINATED SEWAGE

By H. Heukelekian

The previous papers of this series have emphasized that the efficiency of disinfection should be judged on the basis of the residual coliform organisms rather than percentage reduction. The efficiency of any treatment unit, of which chlorination is one, is usually measured on the basis of percentage reduction. The effect of the discharge of a certain pollutant in the effluent on the receiving water can be evaluated more readily if it is measured on the basis of a concentration unit, which can be converted readily to quantity if the volume of the discharge is known. In emphasizing the numbers of coliform organisms in the effluent, therefore, the accent is being shifted and preoccupation shown with the effect of the discharge on the maintenance of a certain level of coliforms in the receiving water. Whatever the level of the desired standard of coliform organisms in the stream water may be, it is affected by the numbers discharged, the degree of dilution by the receiving body of water, and the multiplication or reduction of these organisms after dilution in the receiving water. If, after efficient chlorination and discharge of an effluent with the prescribed low numbers of coliform organisms, these organisms should multiply in the receiving water, the water will be adjudged as not meeting the water quality standards as long as the standards are based on coliform organisms. It is often lost sight of that coliform organisms are used as an indirect measure of the successful destruction of the pathogenic organisms in water. If the coliform organisms contained in the effluent after chlorination multiplied in the receiving water but the pathogenic organisms did not, the value of the coliform organisms as indicators would be enhanced.

It is not the purpose of this paper to discuss the question of the validity of quantitative bacterial standards of receiving waters or to question the validity of basing the standards on the coliform organisms as indicators. The purpose is to show, by laboratory experiments, whether or not the residual coliform organisms in chlorinated effluents multiply when discharged into a receiving water.

The effect of dilution of non-chlorinated sewage on the subsequent rise in the bacterial population has been established (2)(3)(6). The initial rise of bacterial population in streams polluted by sewage has been observed during several stream surveys conducted by the U. S. Public Health Service (2)(6). The aftergrowth of coliform organisms in partly and completely chlorinated sewage without dilution was studied and established by Rudolfs and Gehm (5). More recently, Allen and Brooks (1) showed that chlorinated sewage, upon dilution with river water, gave increase in total bacterial counts, but the number of coliform organisms was not determined.

In view of the above cited indications that there might be a bacterial aftergrowth in streams receiving chlorinated and unchlorinated sewage, it was considered of interest to study under lab-

* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey.

oratory conditions the effect of dilution of chlorinated sewage with different types of water on the numbers of coliform organisms after storage.

Methods

Fresh domestic sewage was procured, settled, and chlorinated to ortho-tolidine residuals of 0.1 and 0.5 p.p.m. after 30-min. contact. After the contact time the various samples were diluted with unpolluted stream water, sea water, and distilled water in the various proportions indicated in the tables. Coliform numbers were determined after the dilutions were made and after different periods of storage in beakers open to the atmosphere but covered with glass covers. The coliform numbers were determined by planting, in triplicate, a series of dilutions into lactose broth. Confirmations were made by transferring the positive presumptives into brilliant-green bile broth. The results are on the basis of the confirmed test expressed as M.P.N. per ml.

Results

The results of two series of experiments are presented. Table I shows results obtained from the dilution of sewage chlorinated to a 30-min. residual of 0.1 p.p.m. In the chlorinated undiluted sewage the numbers of coliform organisms began to increase on the first day and reached a level of 25,000 per ml. on the second. They remained more or less constant at this level for seven days. There was no indication of increase when the concentration of chlorinated sewage in stream water was 5 per cent. When the concentration of chlorinated sewage in stream water was 10 per cent, the numbers began to increase after one day and reached a value of 600 per ml. on the second day, 1,150 per ml. on the fourth day, and down to 25 per ml. on the fifth and seventh days; a level considerably higher than the initial numbers. The increase occurred on the second day with 25 per cent concentration of sewage, but attained a higher maximum level (2,000 per ml.) than the lower concentrations of sewage in fresh water.

In sea water there was no indication at any time and at any concentration of a material multiplication of coliform organisms.

In distilled water the results were similar to those obtained in stream water.

The results of studies of the effect of dilution of sewage chlorinated to a residual of 0.5 p.p.m. are given in Table II. The increase in the undi-

TABLE I.—Aftergrowth of Coliform Organisms in Diluted Chlorinated Sewage[1]

	Sewage Conc. (%)	Type of Dilution Water	Chlorine Residual[2] (p.p.m.)	Coliforms (M.P.N./ml.)[3]						
				0 Days	1 Day	2 Days	3 Days	4 Days	5 Days	7 Days
1.	100	—	0.1	2.5	60	25,000	20,000	25,000	11,500	25,000
2.	5	Stream	0	2.5	2.5	0.6	2.5	2.5	2.5	2.5
3.	10	Stream	0.1	2.5	25	600	60	1,150	25	25
4.	25	Stream	0.1	2.5	3.5	2,000	1,150	950	250	95
5.	5	Sea	0	2.5	2.5	0.2	2.5	2.5	2.5	2.5
6.	10	Sea	0	2.5	2.5	2.5	2.5	2.5	25	2.5
7.	25	Sea	0	2.5	2.5	0.2	2.5	2.5	2.5	2.5
8.	5	Distilled	0	2.5	2.5	2.5	2.5	2.5	2.5	2.5
9.	10	Distilled	0	2.5	2.5	2.5	60	35	3.5	2.5
10.	25	Distilled	0.1	2.5	6.0	600	250	95	200	250

[1] Sewage chlorinated to an ortho-tolidine residual of 0.1 p.p.m. after 30-min. contact.
[2] Residual after dilution; residual absent in all dilutions after 4 hr.
[3] On basis of confirmed counts.

TABLE II.—Aftergrowths of Coliform Organisms in Diluted Chlorinated Sewage[1]

	Sewage Conc. (%)	Type of Dilution Water	Chlorine Residual[2] (p.p.m.)	Coliforms (M.P.N./ml.)[3]						
				0 Days	1 Day	2 Days	3 Days	4 Days	5 Days	7 Days
1.	100	—	0.5	0.2	1,400	16,000+	160,000+	160,000+	160,000+	160,000+
2.	1	Stream	0	0.2	0.2	3.5	0.2	0.3	0.2	0.2
3.	5	Stream	0.1	0.2	0.2	0.2	0.2	2.5	0.2	2.5
4.	10	Stream	0.15	0.2	0.2	0.2	0.2	0.2	0.2	2.0
5.	25	Stream	0.3	0.2	1.3	1,600+	350	350	70,000	11
6.	1	Sea	0	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7.	5	Sea	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2
8.	10	Sea	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2
9.	25	Sea	0.15	0.2	0.2	0.2	0.2	0.2	0.2	2.5
10.	5	Distilled	0	2.5	2.5	3.5	2.5	2.5	2.5	2.5
11.	10	Distilled	0	2.5	2.5	11.5	2.5	55	3.5	2.5
12.	25	Distilled	0	2.5	2.5	350	400	6,000	5.5	165

[1] Sewage chlorinated to ortho-tolidine residual of 0.5 p.p.m. after 30-min. contact.
[2] Residual 3 hr. after dilution; residual absent in all samples 24 hr. after dilution.
[3] On basis of confirmed counts.

luted sewage occurred again on the first day, but attained a much higher level than in the former experiment, in which the sewage was chlorinated to a residual of only 0.1 p.p.m.

In contrast with the former series, no definite increase occurred in the numbers of coliform organisms up to 7 days in the 1, 5, and 10 per cent concentrations of sewage in stream water. In the 25 per cent concentration the numbers increased to a very high level in two days and remained more or less high for five days.

Again, in sea water there was no indication of a material increase of coliform organisms at any of the concentrations used during seven days. In distilled water, as in stream water, a material increase occurred in the 25 per cent settled sewage addition.

Discussion

The foregoing results show that coliform organisms could multiply in stream waters under certain conditions. One of the conditions that seems to affect the multiplication of these organisms is the concentration of sewage or degree of dilution. Food may be the controlling factor. The maximum number attained is affected, in addition, by the residual chlorine in the sewage. The higher the residual chlorine and the fewer the coliform organisms remaining in sewage, the greater the subsequent multiplication upon dilution with stream water, although the multiplication may be somewhat more delayed than with a lower residual chlorine. Similar effects of the quantity of chlorine added and residuals obtained upon the delay and the degree of aftergrowth were shown by Rudolfs and Gehm (5) in undiluted sewage.

The question may be raised whether typhoid and dysentery organisms, which may be discharged with unchlorinated or chlorinated effluents, may similarly multiply under certain conditions. If they multiply, the primary objective of chlorination is defeated and a false sense of security is created. Heukelekian and Schulhoff (4) demonstrated that when pond water was artificially contaminated with feces, urine, or sewage there was a distinct initial increase in the numbers of typhoid organisms during the first 24 hr. However, the contaminated waters were inoculated with a large number of cultured typhoid organisms. It

remains to be seen whether the relatively few typhoid and dysentery organisms that may be found in untreated sewage multiply similarly when discharged into polluted streams. It is assumed that in a properly chlorinated sewage these organisms are not present, hence their multiplication, even in a highly polluted stream, is remote.

If the multiplication of pathogenic organisms in the stream does not take place, little relationship exists between them and the numbers of coliform organisms, particularly if the latter are primarily the result of aftergrowth. This leads to the question whether the quantitative standards based on coliform organisms may have to be revised. To fix an effluent standard of 1 or 2.5 coliform organisms per ml. when under certain conditions they may increase in the stream to thousands per ml. without any possibility of the presence or increase of pathogenic organisms, would seem to make a fetish of destruction of coliform organisms.

Speculations have been made in the past as to the reasons for the increase of coliform organisms. It has been stated that dilution changes the biological balance between the bacteria and predatory protozoa, which, being present in fewer numbers in sewage, are further reduced in numbers by dilution and, therefore, cannot check the increase of bacteria. A similar explanation may be advanced for the increase in the numbers of coliform organisms after chlorination, on the basis that protozoa are eliminated to a greater extent than bacteria by chlorination. When the chlorinated sewage or effluents are diluted with river water containing protozoa, other factors enter. If the residual chlorine in the effluent is too low or the dilution is so great that a residual is not obtained in the mixture, the protozoa in the stream water may keep the bacteria in check. This may be a part of the explanation for the failure or rapid and extensive multiplication of coliform organisms in very low concentrations of effluents. With high chlorine residuals and low dilutions with stream water, it is possible to obtain a chlorine residual in the receiving water which will destroy the protozoa. Thus, the multiplication of the coliform organisms may proceed unhindered in conjunction with high food concentration available and at a slower rate at low food concentration. Similarly multiplication of coliform organisms recorded in potable-water storage basins and distribution systems, where the food supply is presumably at still lower concentrations, would be at a slower rate.

The failure of coliform organisms to multiply materially in sea water may be attributed to the unfavorable effect of the salts present.

Summary and Conclusions

Settled sewage was chlorinated to ortho-tolidine residuals of 0.1 and 0.5 p.p.m. and diluted with unpolluted stream, sea, and distilled water in different proportions. The numbers of coliform organisms during a period of storage up to seven days were determined. The results are presented on the basis of the confirmed test and expressed as M.P.N. per ml.

The following conclusions may be drawn:

1. There is a significant increase in the numbers of coliform organisms when chlorinated sewage is diluted with stream and distilled waters.
2. The increase is greatest in higher concentrations of sewage or effluents.
3. The increase takes place within one day after dilution.
4. The increase is greater when the sewage is chlorinated to a higher residual than with lower residuals.
5. There is no material increase in the numbers of coliform organisms when chlorinated sewage is diluted with sea water.

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COMMISSIONS FOR ENGINEERS *

In general, the conditions governing commissioning of engineers in the armed services are designed to conserve the younger engineers, particularly those graduated from engineering schools within the past four or five years, who are in the present draft age limits and whose skills probably would be permanently lost if they were inducted as enlisted men. A governing factor is the need for the various skills and the number of position vacancies in which they can be applied. Unless a request for extended active duty accompanies the application for commission there is exceedingly small chance that the commission will be granted. A suitable degree is believed necessary in all cases and the applicant must be physically and morally acceptable.

Applications for commissions in the Army (Corps of Engineers or Medical Service Corps) must be made to the Commanding General of the Army in whose area the applicant lives. Headquarters of the various Armies are:

1st: Governors Island, N. Y.
2nd: Baltimore, Md.
3rd: Fort McPherson, Ga.
4th: Chicago, Ill.
5th: San Antonio, Tex.
6th: San Francisco, Calif.

Applications to or requests for information from the Public Health Service should be addressed to the Surgeon General, Public Health Service, Washington 25, D. C.

Applications for Naval Reserve commissions in the Civil Engineer Corps, Naval Intelligence, Naval Architecture, and the Supply Corps, may be secured from and transmitted through Navy Recruiting Stations and Offices of Naval Officer Procurement, located in: Boston, Chicago, Cincinnati, Dallas, Denver, Detroit, Kansas City (Mo.), Los Angeles, Macon (Ga.), Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, Seattle, and Washington, D. C.

An applicant for a commission in the Air Force Medical Service Corps should write a letter to the Surgeon General, U. S. Air Force, Washington 25, D. C., Attention: Medical Liaison and Selection Branch, and request a set of application forms. He will be furnished the forms and complete directions as to the procedures to follow.

Sanitary engineers for civilian overseas assignments are needed to direct and coordinate a sanitation program in Japan. A degree and at least five years of specialized sanitation experience are essentials. The salary is $6,400 plus living quarters; minimum tour of duty is two years; transportation to and from Japan is at government expense. Application should be made to Recruitment Section, Overseas Affairs Branch, Civilian Personnel Division, Office of the Secretary of the Army, Dept. of the Army, Washington 25, D. C.

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RECENT DEVELOPMENTS IN DUAL DISPOSAL—A DISCUSSION *

By B. A. Poole and George K. Erganian

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Mr. Cohn, in discussing the development of dual disposal, has mentioned the city of Jasper, Ind., and its pioneering venture in this field through the mass installation of household grinders. During the period garbage grinders were being installed, the city passed a municipal ordinance governing the collection and disposal of garbage. Although the ordinance states frankly that its intent is to encourage the disposal of garbage and food wastes through garbage grinders into sewers, it does not go quite so far as to "outlaw the garbage can." It does outlaw the garbage can outside the residence and the disposal of garbage except at points designated by the city.

There are approximately 1,100 residences and 167 commercial and industrial establishments within the city with sewer connections. Approximately 790 grinder units have been installed. After accounting for those grinders serving two families and those residences where no cooking is done, there remain about 250 homes with sewer connections yet to be served. A goal of 1,000 grinders installed by the end of the year has been set. Municipal garbage collection was discontinued on August 1, 1950. Since then only minor disposal problems have been encountered. Homes without grinders have either disposed of their own garbage or utilized the services of unlicensed scavengers. Rigid enforcement of the city ordinance is contemplated only after all householders have had adequate opportunity to install grinders.

Couch and Kulin, consulting engineers for Jasper, have published an article (1) presenting cost comparisons and some of the procedures involved in developing the Jasper project. As stated in this article, the treatment plant was designed prior to the development of the plan to install home grinders. Subsequent to the development of the plan, the original design of the plant was revised and aeration tanks, sludge digesters, and sludge beds enlarged by 50, 70, and 60 per cent, respectively.

Joint Study of Effects

Following the decision of Jasper to proceed with the mass installation of grinders, plans were made for a joint study of the effects of this installation on the sanitation of the community. This work is a joint project of the U. S. Public Health Service and the Indiana State Board of Health.

As part of this project, efforts are being made to determine the effect that ground garbage has on the Jasper sewer system. This system is comprised chiefly of 8-in. and 10-in. sanitary sewers with a few private 6-in. laterals and 12-in. trunk sewers. The original system was built about 40 years ago. Grades are generally satisfactory, particularly in the outlying areas. Seven key manholes were chosen for special study. Photographs were taken of the sewers discharging to and leading from

* The original paper, by Morris M. Cohn, appeared in This Journal, **23**, 1, 54 (Jan., 1951). Both the paper and this discussion were presented at the 23rd Annual Meeting, Federation of Sewage and Industrial Wastes Assns.; Washington, D. C.; October 9–12, 1950.

these manholes. Figures 1 and 2 show pictures of some of these sewers in April (before the installation of grinders) and again in October. In all cases there was practically no difference in the amount of sludge deposit in the sewers. Actually, some of the sewers, such as the one shown in Figure 2, which were observed to have sludge deposits in April were found to be clean in October. Street crews report no difficulties that might conceivably be due to grinders.

Among the sewers investigated were two which had grades that provided carrying velocities of 1.75 ft. per sec. These sewers, when observed, were found to be flowing full. Investigation showed that no increase in deposits had occurred in these sewers between April and October.

Effect on Treatment Plant

The sewage treatment plant has been in operation since late in June, 1950. The operator was untrained and the plant is still in the tune-up period.

Several obvious facts, supported by a few tests indicate:

1. There is an increase in grease concentration, but not enough to cause any problem.
2. Moderate to large quantities of grit ranging from 2.5 to 14 cu. ft. of wet grit per million gallons of sewage. Samples were high in moisture content and extremely high in organics.
3. A heavy primary sludge with concentrations up to 7½ per cent was observed (no waste activated sludge was being returned).

Sampling of raw sewage on a 24-hr. basis has been carried on since August, 1950. Basic data were obtained during a two-week sampling survey in March. Data collected since August have been erratic, probably being affected by home canning activities during the latter part of the month.

In terms of pounds of B.O.D., the raw sewage figures in August have ranged from 4.6 to 31.2 per cent greater than during comparable five-day pe-

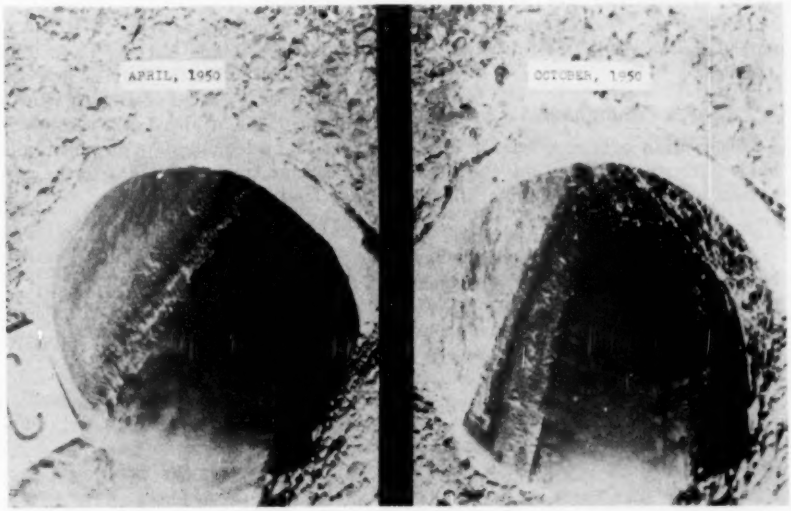

FIGURE 1.—Discharge end of 8-in. sewer having a slope of 6.1 ft. per 1,000 ft. (a carrying velocity of 2.5 ft. per sec. when flowing full). Eighty-two homes are tributary to this sewer, 49 of which are equipped with garbage grinders.

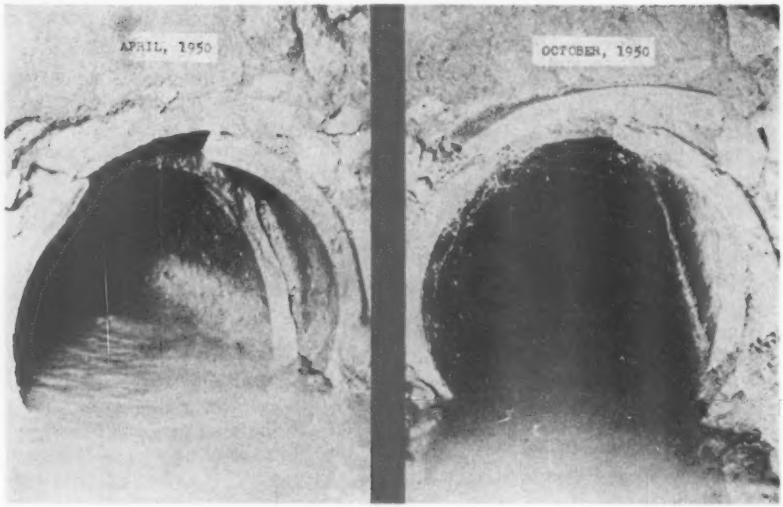

FIGURE 2.—Discharge end of 8-in. sewer having a slope of 3.5 ft. per 1,000 ft. (a carrying velocity of 1.9 ft. per sec. when flowing full). Eighty-five homes are tributary to this sewer, 51 of which are equipped with garbage grinders.

riods in March. Solids data are even more variable. Obviously, considerably more sampling must be done before reliable information can be published concerning the effect of ground garbage on the characteristics of raw sewage at Jasper.

Summary

Observation of the effects of household garbage grinders on the sewer system and treatment plant at Jasper, Ind., show the following:

1. To date no unusual problems have been observed at the sewage treatment plant.
2. No problems have been encountered in plumbing or sewers that have required attention of the city.
3. The garbage collection problem has not been entirely solved. However, no serious difficulty has arisen.
4. Studies being carried on by the U. S. Public Health Service and the Indiana State Board of Health will be continued for at least 12 months in order that adequate data on reaction of the sewage treatment plant to the garbage load will be available.

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Industrial Wastes

PERFORMANCE OF A GRAVITY-TYPE OIL–WATER SEPARATOR ON PETROLEUM REFINERY WASTES *

By R. N. Giles, F. W. Scheineman, C. T. Nicholson, and R. J. Austin

Standard Oil Company (Indiana), Whiting, Ind.

The Whiting, Ind., refinery of the Standard Oil Company (Indiana) is located at the southern end of Lake Michigan and draws its water supply from this source. During recent years, the company has undertaken an extensive program to improve the quality of the refinery waste water, which is discharged to the lake. As a major part of this program, a new oil-water separator has been constructed at a cost of about $3,000,000. The installation was designed in conformance with 1941 recommendations of the American Petroleum Institute and has a capacity of 110 m.g.d. Construction was started in October, 1946, and the separator was completed and placed in service in December, 1948. The purposes of this paper are:

1. To consider the function of a separator in a refinery waste treating system.
2. To review briefly the design basis and construction of the separator.
3. To discuss the performance of the separator.

Whiting Refinery Sewer System

Like nearly all cities, most of the older refineries started with a single sewer system, into which was discharged all waste water; that is, process water, spent cooling water, and sanitary sewage. Subsequent segregation of the sanitary sewage, although expensive, is relatively simple. Separation of the process water from spent cooling water in a 60-year old refinery is a task that can be accomplished only on a long-time basis, if extended shutdowns and excessive expense are to be avoided. Refineries have grown over the years at a pace commensurate with the growth and development of the areas in which they are located. It is easily understandable that their progress and future prospects have been uncertain at times, with the result that their present-day complicated sewer systems and sewage treating facilities are not greatly different from those of many large cities that have experienced unpredicted industrial populations with their attendant demands.

The current Whiting refinery wastewater collection system consists of two main sewer systems, each having its own gravity-type separator. The use of a gravity separator in the refinery sewer system parallels the use of primary settling basins in sanitary sewage treatment; in either instance, a retention period and relatively quiescent conditions are provided, so that substances susceptible to gravity separation may be removed from the main mass of water.

In the Whiting refinery, the spent cooling water collected in one of the sewer systems generally does not contact oil except by occasional accidents,

* Presented at 23rd Annual Meeting, Federation of Sewage and Industrial Wastes Associations; Washington, D. C.; October 9–12, 1950.

such as occur when cooling-box coils or heat exchangers develop leaks. This water is relatively free of oil and suspended matter. The installation of extensive separator facilities on such a system for catching accidental oil spills would be somewhat like providing sewage treatment facilities on a city's storm sewer system. The quality of effluent cooling water presents no operating problems.

The other refinery sewer system collects process water, as well as storm water and appreciable amounts of cooling water. Process water is that which has contacted oil in various refinery operations, such as washing and steam distillation. The separation of oil from this mixture of water discharges offers the relatively complex problems that have led to the installation of the new separator herein described.

The extent of the Whiting refinery sewer system is shown in Table I. The process-water system includes 8.5 mi. of sewers, ranging in size from 24 to 108 in.; equivalent construction for the cooling-water system totals 3.66 mi. In addition to these main sewers, there is, of course, a large amount of sewer construction of less than 24-in. diameter, roughly estimated at 185,000 ft., or 35 mi. The average volume of flow handled in the two systems during 1949 was 195 m.g.d., of which 40 per cent passed through the process-water separator.

TABLE I.—Main Sewers in the Whiting Refinery

Sewer		Process-Water System (ft.)	Cooling-Water System (ft.)
Shape	Size (in.)		
Circular	24	16,700	2,850
Circular	30	2,460	500
Circular	36	10,760	6,750
Circular	42	320	150
Circular	44	0	2,150
Circular	48	3,600	1,400
Circular	54	1,600	1,000
Circular	60	1,060	350
Circular	72	4,100	0
Circular	84	1,100	0
Circular	96	800	1,150
Circular	108	0	2,300
Square	48 × 48	350	0
Rectangular	48 × 72	1,900	0
Square	72 × 72	200	0
Square	96 × 96	0	700
Total		44,950	19,300

Basic Considerations in Oil-Water Separation

The function of an oil-water separator in a refinery sewer system is limited to the removal of oil from the waste waters. In the conventional gravity-type separator this is accomplished in a basically simple manner by directing the waste water into settling chambers, wherein quiescent conditions and sufficient retention time are provided so that the oil and incidental suspended solids separate from the water by differences in specific gravity. As the separation is obtained solely through the force of gravity, it is important that the effect of this force should not be diminished by other factors. In the course of normal refinery operation, however, the character of the influent to the separator is frequently such that the rate of separation of oil from water is retarded. The conditions that limit the effectiveness of an oil-water separator may be described generally as follows:

1. A separator of the gravity-differential type cannot be expected to perform satisfactorily when the influent contains oil, solids, or mixtures of the two, having specific gravities approximately equal to that of water.

2. The presence of emulsions in the influent will reduce the effectiveness of the separator. For the present discussion, an emulsion is defined as a mixture of oil and water that does not separate readily into its component parts because of the presence of extraneous materials (such as finely divided solids or certain chemicals) having the property of dispersing oil

in water or water in oil. It is the oil-in-water type of emulsion that causes the greater concern in operating oil-water gravity separators.

3. The presence of unduly large quantities of settleable solids in the influent will hinder the separation of the oil. In actual practice, significant quantities of such solids are present; it is necessary that the separator design recognize this factor.

About 1930 the petroleum industry, through the American Petroleum Institute, instigated its first study of the design of oil-water separators. The separator design resulting from this study was published in 1933 in the "Manual on the Disposal of Refinery Wastes" (1). It was stated in the publication that a well-operated separator could be expected to produce an effluent containing 30 p.p.m. or less of oil. It has since been established, however, that the analytical methods upon which this figure was based frequently fail to measure all of the oil present in separator effluents.

Relatively few data have been published regarding the effectiveness of oil-water separators used in the petroleum industry. One installation was reported (2) in 1939 to have produced an effluent containing 10 to 15 p.p.m. of oil under favorable flow rates and 30 p.p.m. with less favorable flow rates; considerable emphasis was placed on the necessary absence from the influent of emulsions and chemical wastes. A Canadian refiner has reported (3) that, by the use of chemical flocculation following gravity separation, an effluent containing 2 to 5 p.p.m. of oil has been obtained. A recent publication (4) presents a summary of data obtained from a study of several separators, two of which were of recent design. The first of these followed the 1941 A.P.I. design (5) and produced an effluent containing 26 to 52 p.p.m. of oil. The second separator was of modified design and produced an effluent containing 21 to 40 p.p.m. of oil.

Since the installation of the new separator in the process-water system at Whiting was completed in 1948, the performance of the separator has been followed rather closely. The data collected in this study during a period of one and one-half years provide the basis for the present paper.

Description and Operation of the Oil-Water Separator

The design of the new separator was based on formulas published in the 1941 edition of the A.P.I. "Manual on Disposal of Refinery Wastes" (5). The principal recommendations adopted were as follows:

1. The primary sedimentation basin was designed to provide the smallest surface of water to which all oil globules having diameters of 0.02 cm. or more theoretically will rise within the time it takes the waste water to pass through the chamber. The secondary sedimentation basin was provided with a water area 1.4 times that of the primary basin.

2. The rate of rise of the oil particles in clear water was calculated by Stokes' law. In turbid water, the interference between oil globules and settleable and suspended solid particles tends to reduce the rate of rise. A turbidity coefficient, based on the turbidity of the waste water, was applied to the rate of rise of oil globules in clear water to give a corrected rate of rise that was used in the separator design. (The turbidity correction has since been abandoned by A.P.I. as a design factor, in favor of direct viscosity and specific gravity measurements.)

3. The Reynolds' number was used as a means of determining the cross-sectional area of the chambers. The recommended limits for the Reynolds' number were 10,000 and 20,000, the value being dependent upon the esti-

mated rate of rise of oil globules 0.02 cm. in diameter.

The principal items of the design basis were:

Gravity of waste oil	26° A.P.I.
Turbidity of waste water	400 p.p.m.
Temperature of influent	85° F.
Capacity at 85° F.	110 m.g.d.

The recommendations of the A.P.I. were also followed with respect to other physical dimensions and constructional details of the sedimentation chambers, flight cleaners, oil collection pipes, and other equipment.

Two-Stage Separator Unit

Before the entire separator installation of 34 two-stage units is described, consideration will first be given to a single two-stage unit. A cross-sectional view of such a unit is shown in Figure 1. The unit is 20 ft. wide; primary and secondary chambers are 40.25 and 54.0 ft. in over-all length and have design water depths of 8.0 and 7.5 ft., respectively.

The course of flow is as follows: The waste water passes from the inlet channel through inlet pipes to a distribution box located in the primary chamber. An adjustable weir located on the outlet of the distribution box serves the purposes of assisting in proportioning the total flow among the various two-stage units and distributing the flow evenly across the width of the primary chamber. Upon leaving the distribution box, the water flows through the primary chamber, under an oil retention baffle, and through another set of inlet pipes leading to a distribution box located in the secondary chamber. The primary chamber has a design retention time of 17.2 min., whereas that of the secondary chamber is 22.6 min. After passing through the secondary chamber, the waste water flows under an oil retention baffle, over an adjustable outlet weir, and into the outlet channel.

The flight cleaners in each chamber accumulate the surface oil and deposited sludge for removal. On the top horizontal run the scrapers move the separated oil to a horizontal oil collection pipe, which is manually adjusted. On the return horizontal run along the bottom the sludge is scraped into a sump. The contents of the sump are periodically pumped out through a swing suction pipe.

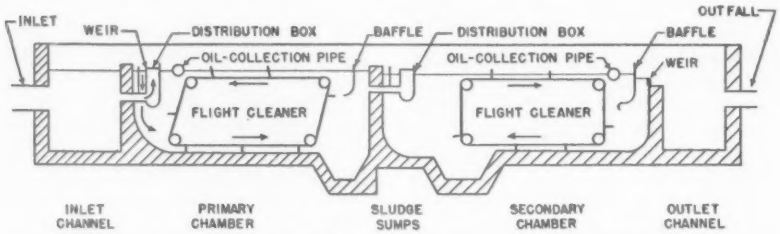

FIGURE 1.—Cross-section of two-stage oil-water separator (A.P.I. design).

The Separator Installation

A plot plan of the separator installation is shown in Figure 2. The over-all dimensions of the separator are 235 by 401 ft., plus an area along one side of 26 by 123 ft. where the effluent-water pumphouse is located. Twenty two-stage separator units are provided at one end and 14 at the other end, where six additional units may be added if required by future refinery expansion. Construction work on the project required 26 months. The quantities of materials used were approximately 20,000 cu. yd. of concrete,

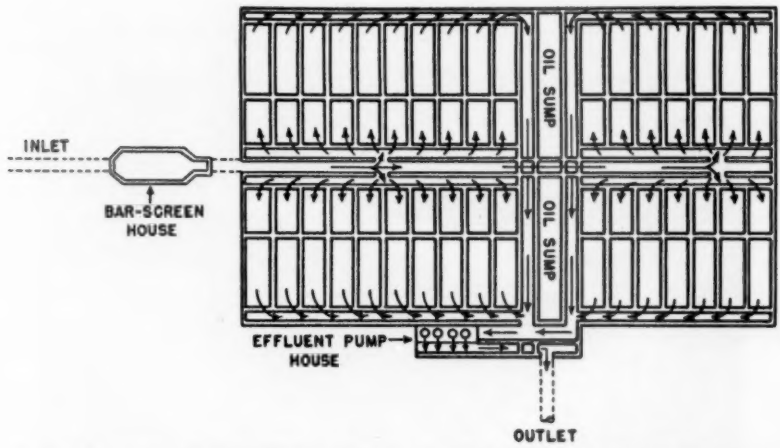

FIGURE 2.—Layout of Whiting refinery oil-water separator and auxiliary equipment.

1,100 tons of reinforcing steel, and 700 tons of structural steel and embedded piping. The total cost for the separator and appurtenances, including engineering expense, was approximately $3,000,000. A photograph of the entire installation is shown in Figure 3. Figure 4 is a close-up photograph of two secondary chambers.

Waste water from the refinery process-water sewer system is screened to remove debris which might interfere with operation of the flight cleaners and the oil and sludge pumps. This material is removed at the bar-screen house, where the water passes through inclined bars spaced to 1-in. clear openings. The debris retained on the screen is removed by a continuous raking device and conveyed to a trash pit.

The water next flows through a measuring flume into an influent sewer extending the length of the separator installation and passes from this sewer through wall openings into four inlet channels. Distribution of the flow to the four groups of two-stage separators is controlled by diversion gates located at the entrances to the two separator groups closest to the bar-screen house. To facilitate removal of the oil and sludge that separate within the inlet

FIGURE 3.—Separator installation, showing pumphouse at center and bar-screen house at right.

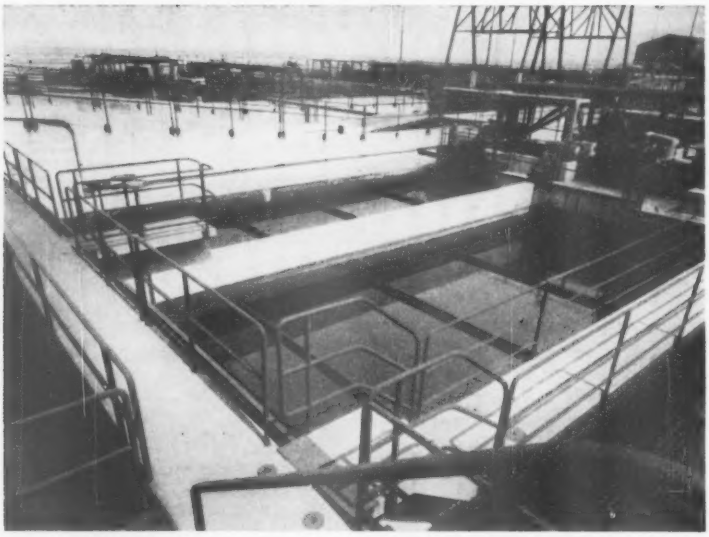

FIGURE 4.—Two secondary chambers (outlet end at left).

channels, each is equipped with two flight cleaners, two oil collection pipes, and two sludge sumps.

As previously described, the waste water then passes from the inlet channels through the various two-stage separator units to the outlet channel.

After leaving the separator units, the effluent flows to a sump beneath the effluent pumphouse. Because the operating water level of the separator installation is below the normal level of Lake Michigan, it is necessary to pump the effluent water. Four vertical centrifugal pumps, each rated at 30 m.g.d. and equipped with a 70-hp. electric motor, are employed in this service. The effluent from these pumps flows through a 96-in. outfall sewer into Lake Michigan.

The oil, emulsion, and incidental water skimmed from the surfaces of the inlet channels and primary and secondary chambers flow through a gravity drain system into two oil sumps located near the center of the separator installation. From here the oil and emulsions are pumped to adjacent treating tanks.

The sludge accumulated in the 76 sediment sumps is pumped to a lagoon. This sludge contains about 5 per cent dry solids.

Operation of the Separator

The separator facilities are operated 24 hr. per day, seven days per week. Operation of the equipment on each shift is the responsibility of a "pumper," whose average refinery experience is 23 years. During the day shift, the pumper is assisted by two helpers in skimming oil, pumping sludge, and coordinating maintenance of equipment. The operating personnel are under the general supervision of a technically trained department head and two assistant foremen. Two machinists and two pipefitters regularly assigned to the separator area are supplemented, when necessary, by other crafts. Considerable attention is given to the project by members of the technical staff.

Oil skimming and desludging operations are confined to the day shift, except during cold weather when the flight scrapers are in continuous operation to prevent freeze-up. All separator units are skimmed daily, particular care being given to secondary chambers; this work can usually be performed by two men in approximately 6 hr. Removal of sludge is on a sequential schedule, the inlet channels being desludged daily, the primary chambers every second day, and the secondary boxes every third day. This cycle has proved satisfactory for preventing large sludge accumulations and overloading of the flight cleaners.

Power and steam are available from the refinery to meet the separator area requirements. Electric power consumption for operation of the flight cleaners, effluent pumps, oil sump pumps, bar-screen house, and lighting averages 3,700 kw.-hr. per day. Consumption of 100-lb. steam for eight steam pumps, steam tracing, and space heating averages 230,000 lb. per day.

Although the new separator recovers substantial amounts of oil to be returned to refinery processing units, the oil so obtained is about 50 per cent more expensive than crude oil brought into the refinery. Operation of the separator is a costly proposition that can be justified only on the basis of improving the quality of the refinery effluent to Lake Michigan.

Performance of the Separator

Numerous equipment problems were encountered during the first few months of operation. The more important of these problems are discussed in the following paragraphs.

The most serious difficulty stemmed from the failure of the eight rotary pumps provided for desludging the inlet channels and the primary and secondary chambers. The required vacuum of 17 in. of mercury could not be maintained and frequent priming was necessary, because of sticking rotor vanes and of vaporization within the sludge lines caused by steam tracing. Machining of the rotor vanes only partially improved the situation. The build-up of sludge in the inlet channels ultimately necessitated replacement of the rotary pumps with four reciprocating steam pumps. Since these replacements were made, a successful desludging schedule has been maintained. Frequent shutdowns are still necessary, however, to clean debris from the suction screens; a continuous screen-cleaning device is being considered.

The four electrically driven pumps that were originally provided for removing oil and water from the oil sumps proved unsatisfactory for this service. The two centrifugal water pumps failed during the first week, because large quantities of grit in the water seeped through the packing and caused bearing failure. These pumps were replaced with two centrifugal sump pumps equipped with water flushing connections to keep erosive material from the bearings; the new pumps have performed satisfactorily. Although rated at 400 bbl. per hr., the two rotary pumps employed for transferring oil and emulsion to the treating tanks delivered as little as 200 to 300 bbl. per hr., even when the treating tanks were only partly full. The pumps frequently lost suction and had to be primed by leveling oil back from the treating tanks. Both pumps failed after less than 500 hr., because erosion was so excessive that the rotor vanes were reduced to about two-thirds of their original dimensions and the liner was gouged to depths of ¼ in. A single reciprocating steam pump then placed in service has proved satisfactory.

After about five months of operation, it was noted that sludge accumulations in the inlet pipes and distribution boxes was causing unequal flow distribution. It has been found necessary at about six-month intervals to insert

stop logs and flush sediment from this equipment.

Analytical Methods

The evaluation of performance of an oil-water separator requires the use of reliable analytical methods for determining the oil content of the influent and effluent water. The field of industrial waste treatment is in a considerably less favorable situation with regard to analytical techniques than is the field of sanitary sewage treatment. In the determination of oil content in industrial waste waters, procedures involving solvent extraction and a combination of solvent extraction and distillation have been employed. The inadequacy of the solvent extraction method used in the early 1930's has led to the development of more reliable techniques.

Three analytical procedures for determining oil content are currently recommended by the A.P.I.; namely, the U-tube, the distillation-extraction, and the Sun Oil Company benzene extraction methods (6). Data obtained by the use of these methods in the Standard Oil Company laboratories at Whiting will serve to illustrate the importance of specifying the particular method employed when discussing oil content results. These data, given in Table II, show that the accuracy of all three methods decreases with increasing oil volatility, as indicated by the specific gravity. For the U-tube method, the average recovery ranged from 93 per cent for the SAE No. 30 oil to 35 per cent for the rerun feed oil; the average recovery from wastewater samples containing typical Whiting separator oil was only 54 per cent. The same trend is observed in the distillation-extraction method, the average recovery ranging from 108 per cent for SAE No. 30 oil to 63 per cent for the rerun feed oil. With this method, a recovery of 83 per cent is indicated for analyses performed on synthetic samples comparable to the Whiting separator effluent. The average recovery by the Sun Oil Company method ranged from 103 per cent for the SAE No. 30 oil to 86 per cent for kerosene; the recovery for synthetic samples corresponding to the Whiting separator effluent was 90 per cent.

TABLE II.—Average Oil Content of Synthetic Oil-Water Samples[1] as Determined by Three Procedures

Oil		Average Recovery from Known Mixtures (%)		
Type	Sp. Gr. (60° F.)	U-Tube	Dist.-Extr.	Sun Oil Co. Method
SAE No. 30	0.916	93	108	103
SAE No. 10	0.893	—	—	100
SAE No. 30, 75%; gasoline, 25%	0.887	85	93	—
Separator oil	0.876	54	83	90
Sep. oil, 50%; rerun feed[2], 50%	0.860	36	72	—
Rerun feed[2]	0.845	35	63	—
Heater oil	0.820	—	—	97
Kerosene	0.816	—	—	86

[1] Oil content ranging from 10 to 200 p.p.m.
[2] A distillate of wide boiling range.

Although the data indicate that the Sun Oil Company method is the most reliable of the three recommended procedures, this method became available after the present study was initiated. Accordingly, the oil content data gathered during the first 18 months of operation of the new Whiting separator were all determined by the distillation-extraction method.

Performance Data

The performance data recorded during the first 18 months of operation of the new separator are summarized in Figure 5. The effluent temperature varied from a low of 59° F. during February, 1949, to a high of 90° F. for August, 1949. This seasonal variation of approximately 30° F. has an appreciable effect upon the quality of the effluent, as the performance of the separator is distinctly better during summer months. An increase in temperature decreases the viscosity of the water and the specific gravity of the oil, and

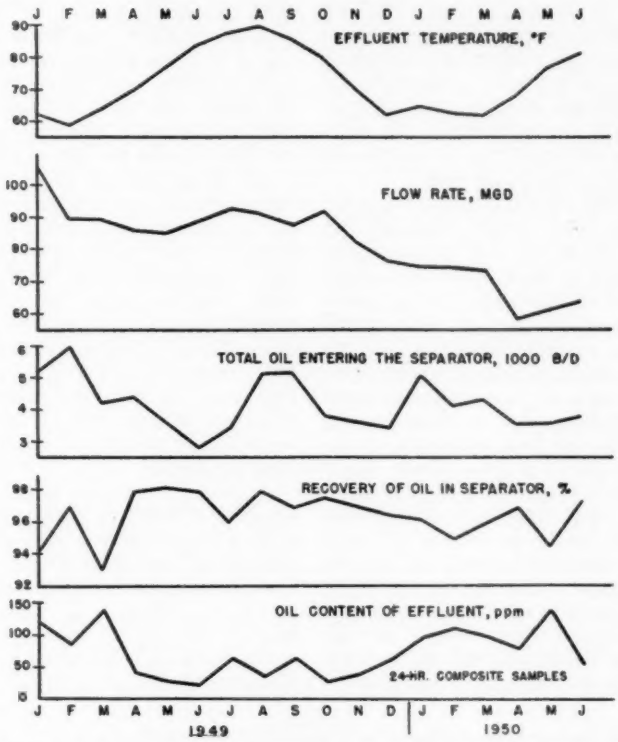
J F M A M J J A S O N D J F M A M J
EFFLUENT TEMPERATURE, °F
FLOW RATE, MGD
TOTAL OIL ENTERING THE SEPARATOR, 1000 B/D
RECOVERY OF OIL IN SEPARATOR, %
OIL CONTENT OF EFFLUENT, ppm
24-HR. COMPOSITE SAMPLES
1949
1950

FIGURE 5.—Summary of performance data on Whiting refinery separator.

thereby results in a greater gravity differential and improved separation.

The flow rate varied from 61 to a peak of 106 m.g.d. Except for the high flow rate recorded in January, 1949, flow rates have been considerably below the design capacity of 110 m.g.d.

The "total oil" entering the separator is calculated as the amount of oil recovered after emulsion treatment of the separator skimmings plus the oil carried out with the effluent. It does not include either the evaporation loss from the surface of the chambers or the loss entailed in the emulsion-treating process, which is carried out at 180° F. The total oil entering the separator has varied between 2,800 and 6,000 bbl. per day; the average volume was 4,160 bbl. per day. Oil recovery by the separator has ranged from 93.1 to 98.4 per cent, the average for the period being 96.7 per cent.

Each point given on the plot showing effluent oil content represents the average of a number of 24-hr. composite samples. These data indicate that there has been considerable fluctuation in the oil content of the separator effluent. The lowest value (25 p.p.m.) was reached in June, 1949.

Discussion

Although data on the oil content of the effluent may reflect the over-all performance of the separator, additional factors must be taken into account before the assumption can be made that

effluent oil content indicates the efficiency of the gravity-separation process. A realistic evaluation of separator performance will also include information on the susceptibility to separation of the influent, particularly in those instances in which the oil content of the effluent is unusually high.

Oil in the separator effluent may result from two primary causes: (1) certain emulsions and non-separable oils present in the influent will not be recovered by a gravity-type separator of practical size; and (2) some of the separable oil and emulsions will be lost because of non-ideal settling conditions, such as convection currents and turbulence due to flow, uneven distribution of flow, operation of the flight cleaners, or exceedingly small size of the droplets of dispersed oil.

Although no direct method for evaluating the individual effects of these various factors is known, the role of each primary cause can be estimated by applying a so-called "susceptibility to separation" (STS) test to the influent and correlating the results with data on the oil content of the effluent. This procedure consists of obtaining a grab sample of the influent, allowing it to settle quiescently for a time approximately equal to the theoretical retention time of the separator (40 min. in this case), and then analyzing the water layer for oil content. The result is interpreted as the nonseparable oil that could not be removed by the separator during the selected retention period, even under ideal settling conditions. This STS value is then compared with the effluent oil content, as determined from a grab sample obtained 40 min. after the influent sample was taken. The difference between these two values is interpreted as separable oil which was not retained because of non-ideal settling conditions.

A summary of such data obtained during the period January 17 to March 2, 1950, is presented in Figure 6. Grab samples of the influent and effluent were obtained on the days indicated at 10:00 and 10:40 A.M., respectively. During this period, the character of the influent represented the most unfavorable operating conditions, because

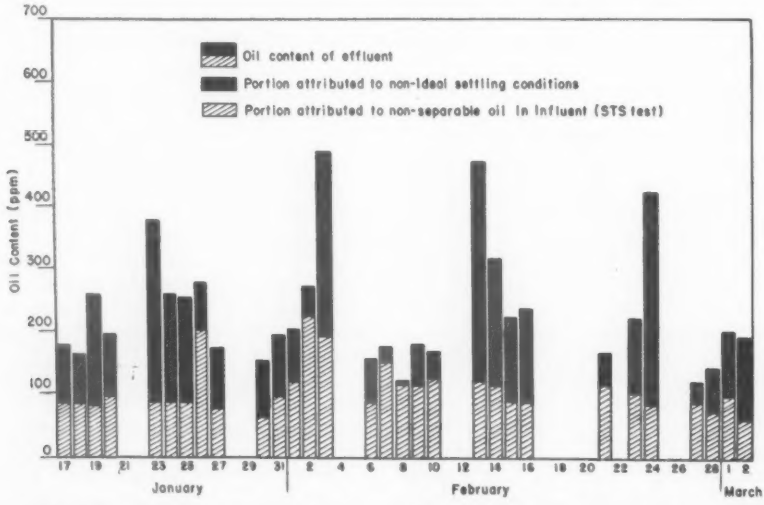

FIGURE 6.—Data on susceptibility to separation (STS) and effluent oil content.

of low influent temperatures and considerably greater refinery activity during the day shift. It is apparent that the oil loss attributed to non-ideal settling conditions in the separator contributes the larger share to the fluctuations in oil content of the effluent. Unsuccessful attempts have been made to correlate these results with flow rates and other variables upon which data were available. It therefore appears that, if the STS technique is valid, there are one or more things taking place in the separator chambers that cannot be observed or measured. The STS results average 108 p.p.m., with an average effluent oil content of 216 p.p.m. These data indicate that the responsibility for the oil remaining in the effluent is evenly divided between the two primary causes. It would be concluded that, with this particular influent, gravity separation could not be expected to produce an average effluent containing less than 108 p.p.m. of oil.

As the oil content of the effluent can be reduced by improving the quality of the separator influent, a program has been initiated in the refinery for this purpose. Improvements have been made by discontinuing the discharge to the sewers of large quantities of solids and chemicals that would promote the emulsification of oil and water within the sewer system. Also, wherever possible, steps have been taken to prevent the entrance of oil into the sewers. At the present time, a detailed study is being made of refinery water consumption, in order to reduce the volume of waste water to a minimum.

Conclusions

Based on one and one-half years of experience with the A.P.I. gravity oil-water separator at the Whiting refinery, it is concluded that:

1. A substantial portion of the effluent oil content can be attributed to inherent features of a gravity-type separator that prevent attainment of ideal settling conditions.

2. The remaining portion of the effluent oil, because of its nonseparability, could not have been removed by a gravity-type separator of practical size.

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DISCUSSION

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The problem of separating oil from large quantities of water has been a matter of increasing importance, particularly to the petroleum refining industry. Powell and Bacon (1), in a recent article on industrial water demand, have pointed out that this industry is second only to that of steel in total water usage and accounts for more than 18 per cent of the 7,800,000 m.g. of water used by the 20 industries listed in their report. Inasmuch as an appreciable portion of the volume used in the petroleum industry is process

water and spent cooling water that cannot be readily isolated for disposal purposes, gravity oil-water separators present the most practical solution of the problem.

The continuous record of performance presented by the authors on the A.P.I.-type separators installed at the Whiting refinery will be of interest to all concerned with the design of sedimentation and flotation chambers. The authors are to be commended for making the data available.

As pointed out, the American Petroleum Institute has, since 1933, published manuals on the disposal of refinery wastes which set forth the criteria to be used in the design of oil-water separators. The series of articles by Hart (2) presents a comprehensive review of the development of the A.P.I. separator.

In a continuing effort to improve the present design, the committee on Disposal of Refinery Wastes established a project at the University of Wisconsin to study the fundamentals of the hydraulic behavior of oil-water mixtures in separators. These studies have been conducted using a lucite tank 10 ft. long by 5 ft. wide by 3 ft. deep constructed on a test platform, which includes an approach channel, waste channel, flow measuring equipment, and other appurtenances required to carry out the experimental program.

The work on the project has been devoted chiefly to a study of various inlet and outlet arrangements and shape factors. The hydraulic behavior of the units under test has been studied by the dispersion technique. In this procedure the influent to the separator is dosed with a chemical tracer whose concentration in the effluent can be measured. The variation of tracer concentration time after dosing can be analyzed to show the way in which the water passes through the separator. Tests of separating performance are conducted by adding continuously to the influent a suspension of small wax spheres. The wax spheres, of about 200-micron diameter, are used to simulate oil droplets. Studies have been conducted over a range of flows varying in mean horizontal velocities in the separator from 0.5 to 2.5 ft. per min., with overflow rates of from about 0.12 to 0.63 ft. per min. Based on the information presented by the authors, the overflow rates at the Whiting refinery installation are computed to be 0.465 ft. per min. for the primary chamber and 0.331 ft. per min. for the secondary chamber. If the two units were to be considered as a single unit, the over-all overflow rate would be 0.156 ft. per min. Again, considering the over-all unit, the overflow rate, expressed as g.p.d. per square foot of surface area, would be 2,060 for a flow of 110 m.g. and 1,145 for a flow of 61 m.g. It will be noted that these values are somewhat higher than those used as a basis for sedimentation tank design in sewage treatment plants.

Although the final results of the studies being conducted at the University of Wisconsin are not yet available, certain features of design can be evaluated. Studies using a vertical overflow weir and a simple vertical baffle indicate that this type of entrance condition provides the hydraulic characteristics of a mixing tank, rather than a settling or flotation tank. Even though the inlet weir provides a free fall of less than 1 in., it is sufficient to produce a nappe velocity which carries the entering water rapidly to the bottom of the tank, from where it is deflected back upward into the body of the tank, producing continuous agitation as well as a distinct region of flow reversal in the upstream, top part of the chamber. The condition in the tank is, thus, anything but that of a quiet, uniform flow necessary to good separation. A study of the dispersion curve shows that serious short-circuiting occurs. It is also observed that low velocities produce serious short-circuiting. The reason for

this lies in the explanation of tank stability. The stability of a chamber is its capacity to absorb minor disturbances and density currents without allowing them to affect the hydraulic behavior (that is, the dispersion curve) to a significant extent. The downward velocity provided by the influent weir is about the same at the low-flow rate as at the high. The disturbing and short-circuiting effect of this velocity, however, is much greater at the low flow because the main flow, in which disturbances are partially absorbed, is much less. This observation agrees with Camp's (3) statement that the hydraulic characteristics improve with increase in the Fronde number.

These results indicate the desirability of submerged inlets or some means of redistribution of flow. Studies on inlet baffles with horizontal or vertical slots show that these are superior to an overflow weir. The advantage of some scheme to start the flow in a horizontal direction has also been claimed by Morrill (4), Imhoff (5), and others. Despite the encouraging results, however, this type of inlet is considered impractical from the standpoint of cleaning. Good results have been obtained using a vertical slotted baffle so constructed that the cross-sectional area of flow through the baffle is from 3 to 7 per cent of the cross-sectional area of the chamber.

The studies thus far conducted indicate that the outlet condition, although of lesser importance than the inlet, does have some effect on hydraulic characteristics. Tanks with square ends appear to be somewhat better than those containing a bottom fillet, but the practical difficulty of preventing sludge accumulation in the square-ended tank will probably rule it out.

The results comparing hydraulic characteristics with wax particle removal indicate that improving hydraulic characteristics results in improved removal performance. In this part of the study the work of Camp (3) was drawn upon freely. Following his theory, it is possible to predict what part of a suspension will be removed in an ideal separator operating at a certain overflow rate. The ratio of the actual to the theoretical removal is then a real measure of performance. This performance may be better than 100 per cent under some conditions, as separators can produce removals better than those for ideal tanks, especially over short lengths of tank. A fundamental problem, however, in oil-water mixtures is the difficulty of characterizing the suspension that is being handled. The "susceptibility to separation" test described by the authors, although not an exact measure of the variation in size of the suspended particles, does provide a basis for consideration of what performance could be expected in an ideal chamber, thus permitting the assignment of a rational meaning to the term "efficiency," defined by Camp as the ratio of the actual removal to that of an ideal tank operating at the same overflow rate.

The performance of gravity separators, as is well-known, is markedly affected by differences in temperature between the influent liquid and the tank contents. Although little control over this factor can be exerted, the inlet which distributes the flow vertically as well as horizontally will result in better performance.

In handling oil-water mixtures, attention must also be given to the problem of pumping the wastes. The influence of pumping in producing emulsions, which are difficult to separate, must be recognized.

One problem which will require increasing attention is that of sludge disposal from oil-water separators. Disposal at most refineries at present is to lagoons. Areas available for such disposal are apt to become difficult to obtain as time goes on and other methods of drying, such as on pre-coat vacuum filters, will require further investigation.

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MOUNT DORA, FLA., BUYS HOME GARBAGE DISPOSERS

The South's first town-wide installation of household garbage disposers was started in Mount Dora, Fla., on January 25, 1951. In an attempt to improve sanitation and simplify garbage collection in the Florida resort community, Mount Dora has contracted to buy General Electric disposers for resale to local householders at a special price of $99.95 installed. The devices are being purchased by the town for direct resale to homeowners, who can pay cash or finance their purchase through a local bank.

An initial shipment of 50 disposers was placed on sale at the city hall on January 25, 1951. Although no legislation compelling installation is contemplated, local authorities hope that every one of the town's 1,500 householders eventually will install the grinders.

At present the town is charging householders $9 per year, or $0.75 per month, for garbage and refuse collection. For these who install disposers this rate will be cut in half, so that they will henceforth pay only for trash collection.

Although Mount Dora has a sewage system, 90 per cent of its houses are connected to septic tanks. However, the manufacturer's representatives have pointed out that garbage disposers work just as well on septic tanks as on a city system, as the small particles into which food wastes are ground are quickly and readily assimilated in the tanks.

The idea for installing disposers on a town-wide basis is credited with stemming from the successful experiments made in Jasper, Ind. [see THIS JOURNAL, **22**, 3, 288 (Mar., 1950); also, **22**, 9, 1138 (Sept., 1950)], and Herrin, Ill. [see THIS JOURNAL, **22**, 12, 1535 (Dec., 1950)].

TREATMENT AND DISPOSAL OF PLATING WASTES *

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One of the most striking and long remembered examples of stream pollution is the catastrophic effect on the biological population of a stream during a fish killing resulting from an excessive concentration of cyanide. Such happenings are not uncommon newspaper items throughout the country. Many states are now assessing substantial fines against those responsible; new and more stringent laws and regulations are being drafted to closely regulate the safe handling and disposal of spent cyanide and plating solutions.

Concern has been expressed by a minority in the electroplating industry that such actions are singling them out —"picking on them." However, in the great majority of cases, the electroplating industry has moved rapidly to "put its house in order" and to correct potentially hazardous conditions before any such industry-wide controls are established.

The efforts of the American Electroplaters Society in establishing research and technical methods, which electroplaters may use to assist them in correctly handling their problems, are especially meritorious. The compilation of a complete bibliography, followed by a thorough critical review of the literature, stands today as the most informative source on the general subject of plating waste disposal (1) (2). The associated activities and the methods used by A.E.S. to inform its membership on plating wastes problems are extremely interesting.

Sources of Plating Wastes

There are two general sources of wastes from plating operations, each of which is distinctive as to volume and chemical characteristics:

1. Batch solutions.
2. Rinse waters, including both non-overflowing reclaim rinses and continuous overflow rinses.

Design or consideration of any waste treatment facility or process requires a categorical separation of all solutions in a plant into one or the other classification, as the treatment of each type is usually different.

Concentrations of batch solutions are generally reported in terms of ounces per gallon. However, in water and sewage terminology, a typical copper cyanide bath might contain 500,000 p.p.m. of copper cyanide. Although authorities are not agreed on the exact toxicity to fish of the cyanide ion, 0.1 p.p.m. is a generally accepted value in natural water. In view of this, there is little wonder that cyanide plating baths are the most hazardous solutions used in industry.

Disposal Methods

The methods used for disposal of waste from plating operations might be divided into the two following general classes in order of importance:

1. Modifications in design and/or operation within the manufacturing process to minimize or eliminate the waste problem.

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2. Installation of a chemical treatment plant to destroy toxic and objectional wastes in plating room effluent.

It is strongly believed that much can be accomplished to eliminate the potential threat of stream pollution by adequate initial plating room design. Obviously, such design should be directed toward the concentrated baths, or physical changes within existing plants. This is apparent when it is considered that the 70 or so fish kills due to cyanide in Michigan following World War II all resulted from the accidental or intentional discard of concentrated baths and not from rinse waters! Under such circumstances, even plants designed primarily to handle rinse waters might be inadequate if suddenly required to handle such strong wastes.

Suggested Modifications in Plating Room Design

Before any chemical treatment plant is designed or installed, every effort first should be made to minimize the danger in continuously handling hazardous plating solutions by adequate engineering design within the plating room. For example, in the oil industry, where large volumes of inflammable liquids are stored, regulations require adequate dikes to confine the contents of oil and gasoline tanks in case of a failure.

By the same analogy, it should become established practice for those tanks in a plating room which contain toxic metals and their salts, as well as acids, alkalis, etc., to be served by gravity fed, non-overflowing, emergency holding tanks (3). A continuous curb of sufficient height should surround the area around each tank containing solutions whose loss would result in stream pollution. Any spillage, drag-out to the floor, leaks, or other losses would then be directed to flow by gravity from inside the curbed area to the holding tank. Obviously, in each plating plant there would be a minimum of two such tanks—one for acidic wastes, including chromium; one for alkaline wastes, including cyanides. With such a layout, rinse waters are piped directly from the individual rinse tanks to the proper waste sewer.

The above is not only good pollution abatement insurance, but also, in many cases, is an economic benefit, as the collection of the contents of just one large metal-plating bath, accidently lost, would go far in paying for the holding tanks. (For example, the loss and subsequent recovery of a 10,000-gal. nickel bath might result in recovery of as much as $10,000 worth of plating solution.)

As a general principle, reclaim rinse tanks should follow all metal-plating baths. In some cases, two such tanks should be installed, one immediately following the other, in order that the subsequent continuously overflowing rinse water would be of low enough cyanide concentration to discard directly to a stream or sewer system without further concern.

Reclaim tanks are very successful in cases where the preceding plating tank is operated at a relatively high temperature. In such cases, the evaporation loss in the plating tank is high and the contents of the reclaim tanks can be readily returned to the plating bath. The fresh water then added to the reclaim tank keeps its concentration of plating chemicals continuously diluted.

When dealing with lower temperature operations, however, the concentration of plating compounds increases in the reclaim tank faster than the evaporation loss of liquid from the plating tank. The concentration in the reclaim tank soon approaches the same concentration of metal salts as the plating tank. When this occurs, the concentration of wastes in the following overflow rinse increases. Ob-

viously, the contents of the reclaim tank will then have to be disposed of to the treatment plant and the tank re-filled with fresh water.

At the Chevrolet plant in Flint, Mich., an interesting evaporation system has been installed in the plating department to handle such problems. Water is simply boiled off the reclaim solution and the low-volume concentrate is then readily returned to the plating bath.

Another frequent source of stream pollution from plating rooms is the filter area. Often the pumps, hoses, or other mechanical equipment used in the transfer or purification of solutions suddenly fail or are carelessly left in such a manner as to siphon out the tank contents to the floor or sewer. As in the case of plating solutions, filter areas should be served by a separate curbed mat draining to a holding tank.

Ventilation systems in plating plants equipped with wet washers to remove fumes from exhausted air often contain high concentrations of chromium, as well as other plating bath constituents. Solutions from such systems should be re-circulated to reduce their volume and occasionally discarded to a disposal plant for further treatment.

Sludges, spent filter cake, etc., should be sent to the waste disposal plant to be "detoxified." Glass containers should be eliminated from plating rooms as a safety precaution (3).

Heat exchangers immersed in plating tanks should be so designed that any leak in an exchanger will not allow cyanide to escape to the sewer system with the cooling water. Likewise, the design should preclude the possibility of a leak of cooling water into the plating solution, resulting in flooding of same to the floor (4).

Engineering-wise, facilities should be installed in all plating plants in such a manner that no dependence will be required on any mechanical equipment in an emergency. This means elimination of any means by which wastes could get away from the plant without treatment.

Cyanide Treatment and Disposal

Following are a few comments concerning various methods for disposing of cyanide wastes. There are many published reports on treatment processes, and for a more detailed review of same the "Critical Review of the Literature Pertaining to the Disposal of Cyanide Wastes" (1) is by far the best to date and should be referred to.

Inasmuch as the above-mentioned review specifically deplores the lack of published data on the disposal of cyanide by the acidification-aeration method, some of the data collected during the operation of the Willow Run Bomber Plant plating waste disposal plant will be presented in more detail.

Comments are presented on the following:

1. Dilution.
2. Ponding.
3. Alkaline chlorination.
4. Electrolytic oxidation.
5. Formation of less-toxic complex ions.
6. Ion exchange.
7. Acidification and aeration.

Dilution

Disposal by dilution of cyanide-bearing plating wastes in sewer systems represents the method used by the greater share of plating plants today, based on the limited survey of Gurnham (5). The difficulty in using this method, however, is the necessity for controlled discharge, uniform concentration, and thorough mixing of the wastes with the diluting medium. It is fraught with the danger that one of these requirements temporarily may not be met.

However, in Detroit, Mich., for example, electroplating wastes are of little concern in the sewer system, due to the tremendous volume of diluting

water available (over 400 m.g.d.). Further, the treatment plant is of the primary type with no sludge digestion. (The digestion process is the portion of the sewage plant most frequently affected by metal-plating wastes.)

In a smaller community, dilution in the sewer, if not to excess, can be utilized as a satisfactory disposal practice for low-concentration rinse waters. This is carried on successfully at the Ford Motor Company's Ypsilanti, Mich., plant in conjunction with the municipality. Formerly, dilute rinse waters went directly to the Huron River without treatment and with no apparent harm. However, they now enter the sewer system, thus utilizing an additional 40 to 1 dilution as a safety factor before eventually reaching the river via the sewage plant effluent. No harm to the sewage plant has been noted in following such a practice for the past two years.

Ponding

With few exceptions, ponding of cyanide wastes is an outmoded, unsafe practice. Dangers inherent in the failure of dikes, pollution of ground water, etc., make it an undesirable disposal method. Greases and solids present in spent solutions eventually seal the subsurface drainage to such an extent that ponds frequently overflow. New additional ponds are continually in demand.

With the nationwide interest in the conservation of ground-water resources, it is but a matter of time until the disposal of such toxic materials to the ground will be prohibited. In Michigan, such a regulation is now being considered by the Water Resources Commission, which would make unlawful the ponding of toxic wastes.

Alkaline Chlorination

The oxidation of cyanide to cyanate in the presence of excess alkalinity, followed by the hydrolysis of the cyanate to carbonate, is the treatment process now generally used in new plating waste disposal plants in the United States. The process is quite simple, rapid, and positive, and has fewer objections than the other chemical methods known. Dobson (6) reported the following reactions, which describe the oxidation:

$$NaCN + 2NaOH + Cl_2 \rightarrow NaCNO + 2NaCl + H_2O$$

$$2NaCNO + 4NaOH + 3Cl_2 \rightarrow 2CO_2 + 6NaCl + N_2 + 2H_2O$$

He cautioned against lowering the pH of the solution during chlorination as the toxic cyanogen chloride might be produced. In practice, either a continuous or batch-type treatment plant can be used and the chlorine applied either as a solution of the gas in water or as a hypochlorite solution.

Recent articles have described some of the plants using alkaline chlorination (7)(8)(9). Priester (10) described an interesting, small, batch treatment plant in Pennsylvania, which utilized calcium hypochlorite as the oxidizing agent.

At the new plating waste treatment plant of the Ford Motor Company, at Monroe, Mich., alkaline chlorination will be used for the treatment of spent concentrated baths and rinse waters. The process will be of the semi-batch type, and described briefly later in this paper.

Electrolytic Oxidation

Wagner (11) recently obtained a patent covering the electrolytic process for destruction of cyanide in plating baths and recovery of metals. The process involves electrolyzing a spent cyanide bath at 200° F. until the cyanide content is as low as 4 p.p.m. Ventilation must be provided and aeration speeds the reaction. Current density was not considered critical. Usual plating room equipment is used.

Sperry and Caldwell (12) reported their laboratory and plant-scale work on the same process. In the plant-scale

test, 700 gal. of a spent copper cyanide bath was destroyed. Cyanide was reduced from 2.83 oz. per gal. to 0 oz. per gal. in 40 hr. The copper content was reduced from 2.16 oz. per gal. to 0 oz. per gal. in 18 hr. Considerable data and graphs were presented, which would enable others to duplicate the work.

Kessler and Oyler (13) reported the use of the same process for destroying sludges filtered from plating solutions. They indicated the necessity for high temperature (200° F.), vigorous aeration, use of copper electrodes, a high current density, and a high anode-to-cathode ratio. They further pointed out that the use of copper electrodes was not considered a cost item, as they were vehicles in salvaging the copper recovered in the process.

It would appear that electrolytic oxidation of concentrated baths will find increasing use in plating establishments.

Formation of Less Toxic Complex Ions

There are a number of processes by which hydrocyanic acid or its salts can be converted to a less toxic form. Three of these methods are:

1. Treatment with sulfur compounds.
2. Treatment with iron compounds.
3. Reaction with spent nickel solutions.

Conversion of cyanides to the less toxic thiocyanates by boiling with a lime-sulfur mixture, or the addition of various polysulfide chemicals, has been largely superseded. A patent was issued to Wernlund and Zunick (14) covering this type of treatment. However, due to the incompleteness of the reaction, the possibility of later hydrolysis of the thiocyanate and liberation of cyanide, the large volume of sludge produced, and the problem of excess sulfides in the effluent, the treatment more or less has been dropped.

Treatment of cyanides with iron salts produces a complex iron compound, either the precipitate Prussian blue or the soluble (Turnbull's) blue. The reaction is time consuming, and does not go to completion. Southgate (18) indicated that the reaction is already used on a large scale in England, but did not report any specific locations. He further pointed out that the results of experimental work on the use of ferrous sulfate and lime in the absence of air and indicated that a solution of KCN containing 408 p.p.m. as HCN can be reduced to 0.14 p.p.m. after 4 hr. Some work on this process was carried on in the laboratory at the Willow Run disposal plant during the war, but reaction rates with the metal cyanides were so slow that the method was abandoned.

It would appear that any use of ferrous sulfate to produce complex cyanides as a disposal method should be carefully scrutinized in relation to the receiving stream. Any impoundment of the stream below an effluent discharge might be hazardous, due to the effect of sunlight and natural factors, which would stimulate hydrolysis and the liberation of cyanide. More data is needed on how tightly bound the complex will remain in natural water before it can be used extensively.

Milne (16) has recently presented a theoretical approach to the subject of disposal of cyanides by formation of less toxic complex ions. The chemistry of the nickelocyanide complex is dealt with in detail, and the conclusion presented that such a complexation process, based on an examination of the chemical properties of nickel and cyanide holds considerable promise.

Ion Exchange

To date there have been many studies on ion exchange as a means of concentrating plating wastes. In general, the problem of regeneration of solutions still remains a hurdle that has not been satisfactorily and economically solved.

Acidification and Aeration

Acidification and aeration has been reported by Eldridge (17) and Oeming (18), and has been installed at the Chevrolet Motor Company plant at Flint, Mich., and the Willow Run bomber plant (Figure 1). The latter was functionally designed by the writer and his staff of the Waste Section, Ford Motor Company.

Herda (19) and Bleiweiss (20) have already described this plant in detail; therefore, its description is not repeated here. Instead, a few observations and conclusions which led to a change in treatment practice for the new Ford Monroe plant will be given.

Figure 2 is a graph of two typical batch treatment operations of cyanide removal, picked at random. It will be noted that there is a fairly rapid initial reduction in cyanide, which tapers off as aeration continues.

One of the major difficulties in such acidification and aeration treatment is the slow hydrolysis of complex metal cyanides in low pH solutions subject to violent agitation and aeration. The free cyanide or alkaline salts are removed readily but the metal salts take so long to completely react that aeration costs become considerable. This fact was largely responsible for the decision to provide alkaline chlorination for cyanide treatment at the new Monroe plant.

In an attempt to speed up the reaction some early work was done on the addition of chlorine to the acidified cyanide wastes. Figures 3 and 4 show the effect of adding chlorine to 27,000-gal. batches of the acidified waste during aeration. The quantity of chlorine used was in the ratio of 3.2 lb. per lb. of cyanide. The time consumed in the latter case was limited by how fast the chlorine could be applied. The addition of chlorine reduced the usual aeration time from 360 to 30 hr. The bomber plant was abandoned by the Ford Motor Company shortly after this work was started, thus no further quantitative data is available.

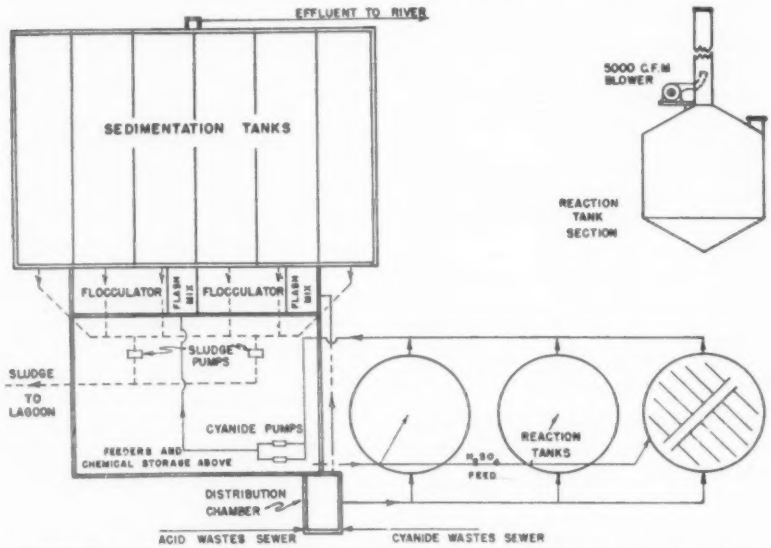

FIGURE 1.—Flow sheet for plating wastes treatment at Willow Run bomber plant.

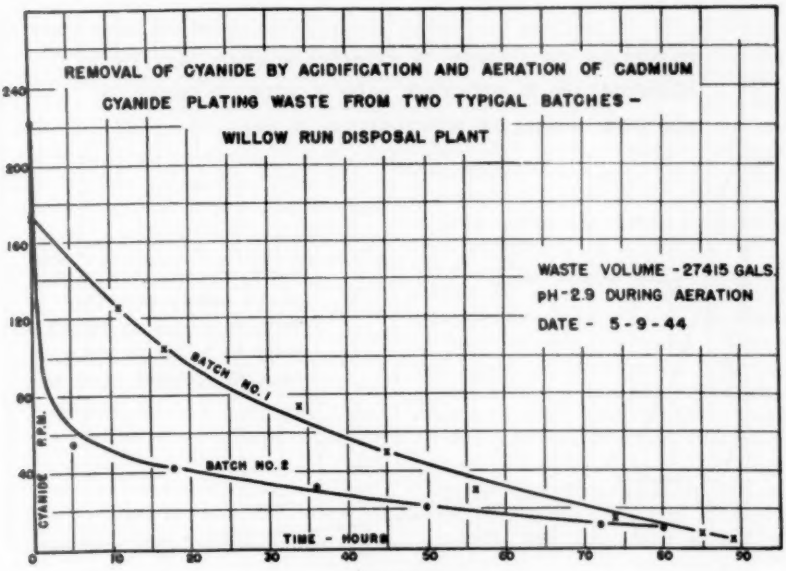

FIGURE 2.

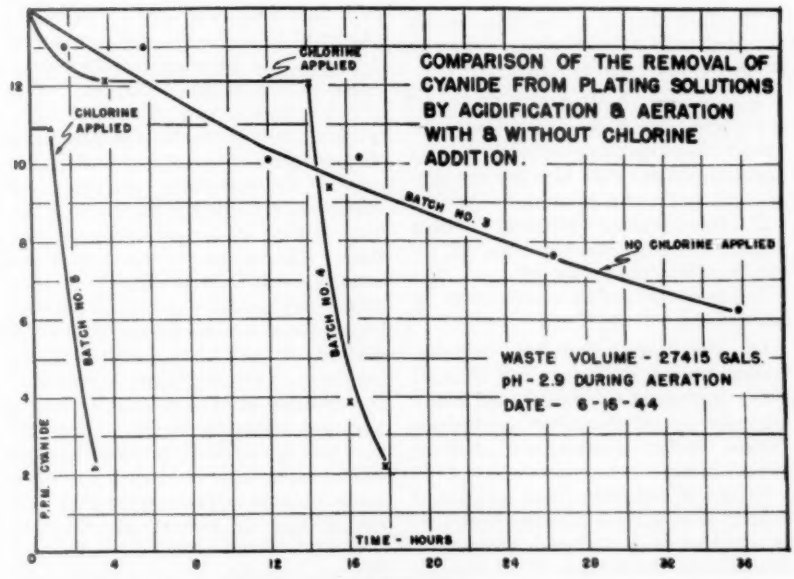

FIGURE 3.

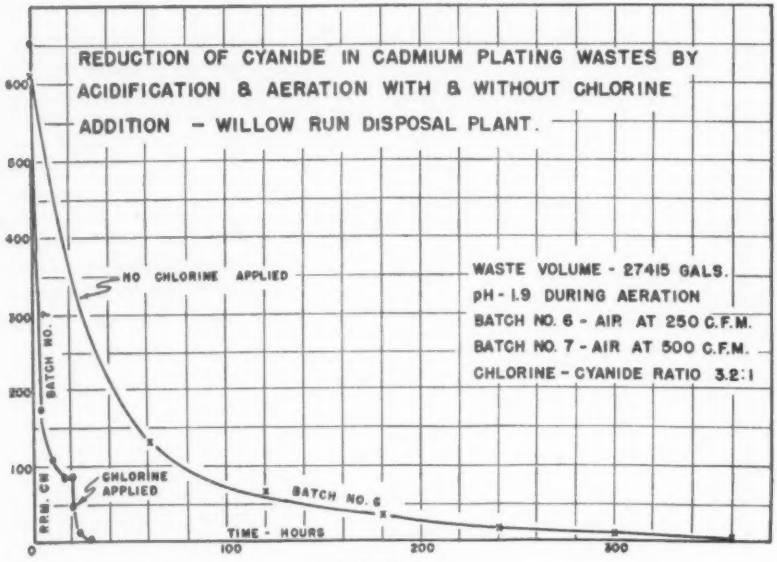

FIGURE 4.

Treatment of Chromium Wastes from Plating Baths

The following is a classification for the treatment of chromium wastes as proposed by Grindley (21):

1. Reduction methods.—Addition of a reducing agent to reduce the hexavalent chromium to trivalent. Subsequent treatment with alkaline agent to precipitate the chromium as hydroxide.
2. Precipitation methods.—Direct precipitation of chromium as an insoluble salt of chromic acid.
3. Absorption methods.—Removal by ion exchange.

Of the many chemical reducing agents studied by Hoover and Masselli (22), those most commonly used today for reduction of chromium are ferrous sulfate, sulfur dioxide, and sodium metabisulfite.

At the Willow Run plant mentioned earlier, a solution of commercial ferrous sulfate was used and found very satisfactory. Reduction of the chromium was rapid in the acid solutions (pH 2.5 to 3.0); hexavalent chromium was consistently absent in the effluent of treated batches of wastes. The major objection to its use was the voluminous quantity and poor settling characteristics of the sludge. Figure 5 is a graph prepared by Madarasz (27), while chemist at the Willow Run waste disposal plant, showing the volume occupied by increasing quantities of chromium following reduction with ferrous sulfate and neutralization with lime. The sludge is light, does not compact well, and is difficult to keep from carrying over the effluent weirs of conventional settling basins. The solids content of the slurry pumped to the lagoon from settling basins is very low; for example, at Willow Run, about 0.5 per cent solids by weight. Rates of flow through up-flow clarification units can be expected to be much lower when using ferrous sulfate rather than sulfur dioxide or sodium metabisulfite.

Sodium metabisulfite is used at the Electric Auto-Lite's plating waste treatment plant at Lockland, Ohio, and

seems to be a very convenient reducing agent insofar as material handling at the treatment plant is concerned. It is slightly more expensive than sulfur dioxide or ferrous sulfate. However, according to Reed (24), chemist-in-charge of waste treatment, the ease of handling more than offsets the difference in unit costs. It is fed continuously with ordinary dry feed machines.

Sulfur dioxide is frequently used for reducing chromium in an acid solution. A recent installation is at the King-Seeley Corporation, Dexter, Mich. The SO_2 is purchased in cylinders and fed to the continuous rinse-water flow entering the treatment plant with a machine similar in construction to the well-known chlorinators used in water and sewage treatment. Quite an excess of the chemical appears to be required in plant practice over that theoretically needed to effectively reduce the chromium; otherwise it is a very satisfactory treatment process.

Precipitation methods have been reported in England by Grindley (21) and in the United States by the Connecticut State Water Commission (23). Having had no experience with this particular method of chromium removal, the author reserves comment. Literature references are rather meager, and detailed information is lacking concerning plants which have used the method.

Ion exchange studies have been carried on by a great number of investigators in the past few years. Advances in the development of improved cation and anion exchange resins have accelerated the research effort directed at finding a commercially feasible process for concentrating chromium from waste waters. As in the case of cyanide removal by ion exchange, complete regeneration of the resin still remains a difficult matter. Southgate (25) summarized his chapter on methods of chromium waste treatment with the observation that "it has great promise

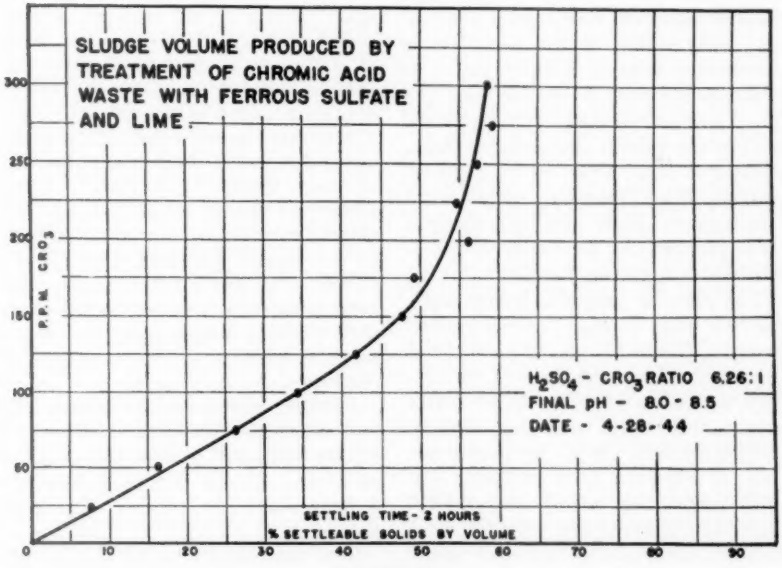

FIGURE 5.

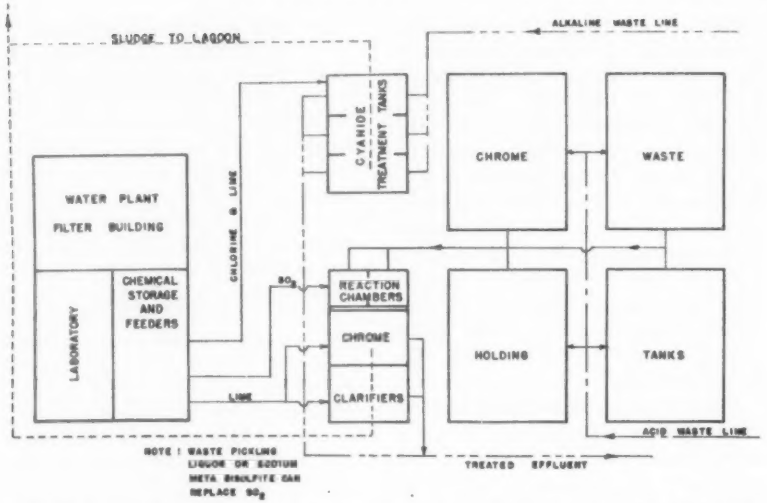

FIGURE 6.—Flow sheet for waste treatment at Ford Motor Co. plant, Monroe, Mich.

as a method of recovery of valuable material."

Of interest to those concerned with plating wastes problems, will be the new combined water softening and plating waste treatment plant now under construction at the Ford Motor Company's Monroe, Mich., plant.

As in the case at Willow Run, the plant was functionally designed by the staff of the Special and Sanitary Engineering Section, Office of Plant Engineering, Ford Motor Co., and detailed construction plans and specifications were prepared by George E. Hubbell, consulting engineer, Detroit.

The plant is unique in many ways, not the least of which is the general layout (Figure 6), which permits the use of the chemical feeders, laboratory, operators, etc., for either water treatment or waste treatment. Equipment is available for the complete treatment of 800 g.p.m. of acid wastes containing chromium, nickel, etc., and 300 g.p.m. of cyanide wastes. Although the volumes are large, a semi-batch treatment plant is provided to give better assurance that wastes will be adequately treated.

Four 200,000-gal. acid-proofed concrete holding tanks are provided to collect acid wastes. When a tank is full and analysis of its contents is completed, treatment on a continuous basis at 800 g.p.m. is started. Ferrous sulfate, sodium metabisulfite, or sulfur dioxide is added as desired, mixed for 5 to 15 min., lime is added, and the flow again mixed. It then passes into one of two Walker "Clariflow" units, where the sludge settles out and the effluent goes to the sewer or, in case of inadequate treatment, can be returned to an empty holding tank. Arrangements are included to use waste steel pickling liquor from the Rouge plant as a source of ferrous sulfate, if desired.

Cyanide wastes will be collected in one of three 20,000-gal. holding and mixing tanks and treated with chlorine and lime. Sludge will be pumped to a lagoon and the treated effluent to the sewer.

The water plant is a 4-m.g.d. lime softening plant utilizing Lake Erie as

the source. Low tolerances for both suspended and dissolved solids and hardness require a high degree of purification. Provision for split treatment is provided with the two "Clariflow" settling units. Four conventional rapid sand filters and filter and chemical building complete the major units. The plating waste portion of the plant will be the largest one yet built in the world and more detailed reports on its design and operation will probably be forthcoming in the future.

It might be of interest to point out that one of the most perplexing problems involved in plating waste treatment plant design and construction is the proper and intelligent choice of special materials of construction, such as coating materials, metals, etc. Certainly an investigation and report on experience with those materials which have been used in other plants, would be most welcome.

Other observations involving the future and plating wastes include:

1. Utilization on a broader scale of the relatively non-toxic metal pyrophosphate salts in place of metal cyanides in plating baths, provides a means by which some plating plants may reduce their cyanide problems.

2. The expanded use of "gas plating" (26), utilizing metal carbonyls, is on the horizon. Its impact may reduce stream pollution by eliminating liquid plating baths. However, increased air pollution hazards might offset the gains.

Discussion of the controversial subjects of stream standards, difficulty in laboratory methods, effects on sewage plants, etc., are items which have been left out of the paper intentionally. Nevertheless, they are extremely important and require consideration in any plant design.

Summary

1. The American Electroplaters Society is actively underway in assisting its membership on plating waste disposal problems. Its critical review of the literature (2) is the most useful source of information yet available.

2. Correction of plating problems should start within the plant. Areas around tanks containing toxic chemicals should be curbed and a separate mat underneath should drain by gravity any accidental spills or leaks to a non-overflowing tank.

3. Reclaim rinse tanks should be required following all concentrated plating baths.

4. Adequate initial design or physical changes within existing plants should be the first and guiding principle to eliminate plating waste problems.

5. Of the many methods available for cyanide waste treatment, alkali chlorination is the one recommended and now in general use.

6. Use of chlorination in acid solutions at the Willow Run bomber plant is reported briefly.

7. Chromium wastes are most readily treated by reduction and precipitation with lime. Sulfur dioxide and sodium metabisulfite are preferred reducing agents; however, a local source of waste acid pickling liquor may make ferrous sulfate more advantageous.

8. The new Ford-Monroe plating waste treatment plant, which will be the largest yet installed in the country when completed late in 1950, is described briefly.

9. Mention is made of the possible use of metal pyrophosphates in place of metal cyanides to eliminate cyanide completely from plating rooms.

10. Mention of the future use of the "gas plating" carbonyl process is also made.

11. A plea is made for more studies and publications on the specialized construction materials used in plating waste plants. Experience with various types of metals, coating materials, etc., is needed.

Acknowledgments

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DISCUSSION

By A. K. Graham

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The remarks contained herein should in no way be interpreted as criticism of what has been presented, but rather as a desire to cooperate in establishing a clearer understanding of the problems presented in treating plating waste, as well as the desire to pool information for the good of the entire industry.

As the author has referred to the activities of the Research Committee of the American Electroplaters Society in this field, a brief report on the present status of these matters may be of interest. From the fall of 1944 to March 31, 1950, the Society spent slightly over $132,000 on its research program. This program includes Project No. 2 on "Determination of Impurities in Plating Baths and Plating Effluents," and Project No. 10 on "Disposal of Plating Waste." Approximately $20,000, or 15 per cent of the total sum mentioned above, was spent on these two projects. The first project is now to be directed wholly to the development of methods of tests for constituents in plating effluents, in order to supply data for Subcommittee I of the Metal Finishing Industry Action Committee of the Ohio River Valley Water Sanitation Commission. This Subcommittee is to recommend standard procedures for determining constituents in waste requiring control. During the current fiscal year, approximately $11,500 will be spent on Projects No. 2 and No. 10 alone, which represents 38 per cent of an estimated $30,000 annual budget for research. If and when more funds are available, it is planned to step up the activity on these projects.

At the request of the president of the Society, the Research Committee recently agreed to an advance release of information from Project No. 2 on the methods of analysis of trace quantities of cyanide and cyanate to several plants in the Ohio River Valley for plant evaluation of the methods for the control of these constituents in plating effluents.

The work of Project No. 10 for the immediate future includes the following:

1. Possibility of oxidation of cyanides with chromic acid.
2. Possibility of destruction of cyanates through acid hydrolysis using chromic acid.
3. Effect of conditions, such as pH, temperature, concentrations, and agitation, on the evolution of hydrogen cyanide gas.
4. Removal of cyanides through ion exchange as a concentration method.
5. Removal of cyanides with ferrous sulfate and caustic soda.

Mr. Cooper states that there are two general sources of waste from plating operations—batch solutions and rinse waters. He then proceeds to discuss other possible sources of waste. It is believed more accurate to say that all of the waste originates from the batch solutions; that which enters the effluent through the rinse waters is but one of a number of avenues of contamination. For example, in the operation of a filter, the disposal of the filter waste, and the operation of pumps and valves there may be leaks and sources of contamination all originating from the batch solutions. In addition, cooling coils have been a source of serious contamination when they develop leaks. Fume washer losses and accidental siphon losses have also been mentioned in the paper.

What the author has stated regarding proper operation of reclaim rinse tanks is of vital importance. To this should be added the importance of instituting drag-out controls, other than reclaim rinse tanks, as a means of reducing the quantity of waste chemicals to be treated. This is also a matter of great economic importance.

Aside from the many interesting practical details presented in this paper, the author has consistently pointed in the direction of further research and development. There is much remaining to be done. Recently, the value of research has again been illustrated in a report of the A. E. S. Research Project No. 10, as yet unpublished, which points out that the presence of nickel reduces the rate of oxidation of cyanide with hypochlorite so severely that the separation of waste containing nickel from cyanide waste is recommended.

Another case is a better understanding of the reactions involved when reducing hexavalent chromium with ferrous sulfate and/or sulfur dioxide (as SO_2, sulfite, or metabisulfite). It has been found that the pH during the reduction is a very important variable influencing the rate of reaction and the degree of completion of the reduction. It also has been found that considerable excess of sulfite may be present in a waste without complete reduction of hexavalent chromium. Experience indicates that ferrous sulfate would give a much sharper end-point for complete reduction. When both sulfur dioxide and ferrous sulfate are present, some rather peculiar effects have also been observed in reducing hexavalent chromium. It is hoped that more can be published on this matter in the near future.

The author has mentioned the possible use of pyrophosphate plating electrolytes in place of the toxic cyanides. A word of caution is called for in this connection. Practical plating baths involving pyrophosphates are not available for most of the metals currently plated from cyanide baths. Furthermore, the quality of the deposits obtained from the pyrophosphate baths that are available are not necessarily equivalent to those obtained from cyanide baths. There are quality and economic differences, which may determine what type of electrolyte should be used.

Mention is also made of "gas plating" using metal carbonyls. There are undoubtedly places where films produced by decomposition of metal carbonyls will find application. Based on the present knowledge of the formation of metal carbonyls, the properties of the films, and what is required in their application, it is extremely unlikely that their use will in any way affect the current problem of plating waste disposal.

THE OPERATOR'S CORNER

CONDUCTED BY HERBERT P. ORLAND

TROUBLE STRIKES WHERE LEAST EXPECTED

The two unusual accidents described elsewhere in this "Corner" offer strong evidence that sewage treatment plant operation is anything but the "push-button" job so many seem to think it to be. It is just such unforeseeable occurrences that tax to the utmost the ingenuity and resourcefulness of operators and managers.

In neither of the cases mentioned could normal plant inspection procedures possibly have revealed incipient failure of the equipment involved. Who would expect an entire welded joint of a tank to fail instantaneously, as this one did, rather than to simply spring a leak and release the pressure? Also, who could anticipate a breakdown of electrical insulation in a rigid conduit after some years of successful service and no evident mechanical abrasion? These apparently are just instances of unforeseeable conditions adding up to the right combinations for disaster to strike.

Fortunately, neither the Edwardsville fire nor the Urbana-Champaign pressure tank explosion resulted in personnel casualty. In the case of the fire nobody was on duty, but in the case of the tank explosion it was just pure luck that nobody was in or close to the building at the time.

Eternal vigilance is necessary to prevent such disasters from striking. If they should occur, there is always the problem of continuing operation and repairing the damage. This is where advance planning and a thorough knowledge of one's plant comes into play. Temporary arrangements for by-passing the affected units or reducing the degree of treatment may not be of the best, but partial treatment is preferable to none. Here is where flexibility of plant and thorough training of personnel pay off.

Obviously, there is the question of money to pay for the repairs and refitting. Fire damage, of course, is normally coverable by insurance. However, boiler insurance usually is not extended to pressure vessels unless some type of heating device is employed. In the case of the exploded tank described, only cold plant effluent was involved. This raises the question as to whether suitable property damage clauses were included in the plant insurance to cover such an incident. It would be well for plant superintendents having unheated pressure vessels in their layouts to review their coverage on this point.

The water tank explosion at the Urbana-Champaign plant will not affect plant operation as such, resulting only in inconvenience with regard to plant water facilities. However, we imagine that Superintendent Beatty heartily agrees with the sentiments of the current song that says "Get out of here with that BOOM, BOOM, BOOM!"

H. P. O.

UNUSUAL ACCIDENTS AT TWO ILLINOIS PLANTS

ELECTRICAL FIRE DESTROYS EDWARDSVILLE CONTROLS

Fire, believed caused by a short circuit, gutted the brick one-story control building of the Edwardsville, Ill., sewage treatment plant in the early morning hours of November 28, 1950. Only the brick walls were left standing (Figure 1), the flames destroying the slate-covered roof and all contents on the ground floor, including the plant's electric control board (Figure 2).

According to the Edwardsville *Intelligencer*, the building and contents were insured for approximately $19,000, thought to be sufficient to cover the entire loss. The basement of the structure, flooded with water during the fire, housed plant pumping equipment, including nine electric motors. Damage to the electric motors could not be ascertained immediately, although Superintendent Robert Paproth believed only drying and cleaning would be required. Loss of the control system, however, will necessitate bypassing of the sewage reaching the $200,000 plant for an indefinite period pending reconstruction and replacement. The 0.9-m.g.d. activated sludge plant provides comminution, grit removal, primary settling, diffused air aeration, secondary settling, stage sludge digestion with gas utilization, and sludge drying on open beds.

WATER TANK EXPLODES AT URBANA-CHAMPAIGN

Structural and equipment damage estimated at about $2,000 was caused at the sewage treatment plant of the Urbana-Champaign (Ill.) Sanitary District on January 7, 1951, when a water pressure tank exploded. The welded

FIGURE 1.—Control and pump building at Edwardsville, Ill., sewage treatment plant following fire forcing indefinite suspension of operation. (Edwardsville, Ill., *Intelligencer* photo by Frank Strejcek.)

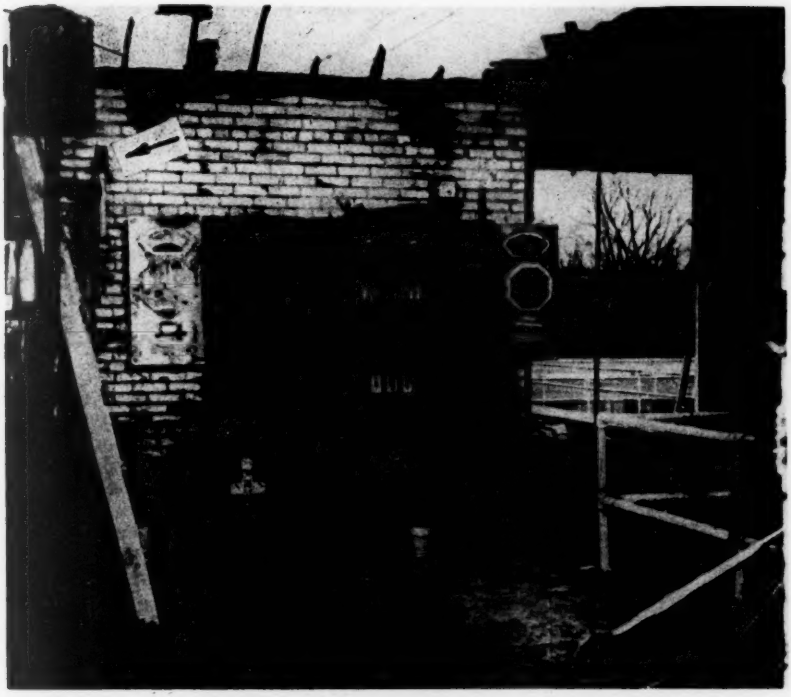

FIGURE 2.—Interior of burned out control building. Arrow (upper left) points to pull box and fused electrical conduit where short circuit is believed to have started fire. (Edwardsville, Ill., *Intelligencer* photo by Frank Strejcek.)

steel tank, 4 ft. in diameter and 8 ft. high, acted as a pressure reservoir in the plant's water distribution system, which uses secondary clarifier effluent for plant purposes, particularly hose flushing.

The cause of the tank failure was not immediately ascertainable. According to E. J. Beatty, engineer-manager of the District, the tank failure was apparently a sudden rupture of the weld joining the concave bottom to the tank side, as the bottom stayed in place (Figure 3) while the remainder of the 20-year old tank "shot up like a torpedo" through the tile roof of the auxiliary pumphouse. A careful plant inspection of the tank's pressure controls and relief mechanisms (55-lb. shut-off pressure) had been made only a few days prior to the disaster. However, inspection of the tank interior following the explosion revealed a heavy accumulation of rust and foreign material.

The force of the explosion was evident from the fact that the heavy steel tank rose almost vertically through the roof, taking along some of the connecting piping as it did so, and landed some 20 to 30 ft. away next to the secondary clarifier (Figure 4). How high it went will never be known, as the "take off" occurred just after the 4 P.M. shift change when nobody was near that portion of the plant. Roof tiles and chimney brick were scattered over a wide area, some two bushels of debris

FIGURE 3.—Bottom of 4-ft. diameter effluent water pressure tank (under operator's feet) remained in place when tank body "took off" through pumphouse roof.

FIGURE 4.—Welded steel pressure tank (4 ft. diameter by 8 ft. high) came to rest against final clarifier track (extreme left) amid tiles and chimney brick torn loose as it traveled through roof. Note pumphouse door torn off by pressure released within pumphouse when tank failed.

being found in the secondary clarifier, whose nearest point is at least 30 ft. from the building. The heavy concrete chimney cap landed in the effluent channel, also some 30 ft. from the building. An oil heater within the pumphouse was overturned, but the flame was extinguished and no fire resulted. Other equipment was damaged slightly.

BREAKING IN A PLANT FOR TREATING GUM WASTES *

By Harold E. Orford

This paper discusses the first few months' operation of a complete treatment plant handling a concentrated organic waste, with particular reference to the "breaking in" of the natural gum waste treatment plant of the L. A. Dreyfus Company in South Plainfield, N. J.

"Breaking In" Requirements

What is meant by "breaking in" a waste treatment plant? The following are a few of the things that should be done before a plant can be considered "broken in":

1. Become familiar with and check all structures and equipment; start operation.
2. Secure operating data to determine optimum operation for the many variable conditions of load.
3. Determine the sampling and analysis routine to get the necessary data for best operation.
4. Experiment with operation to determine optimum routine operating methods.

To secure this really vital information there are a few essential requirements.

Personnel

A good, patient, optimistic operator is required. Also, he should be provided with plenty of help, at least during the breaking in period, so that time is available for making analyses, keeping rather elaborate records, and study. It helps to have the operator on the job during the construction period and, if possible, during the development of the treatment method.

Analyses

Laboratory space, equipment, and help for making the analyses are certainly necessary. During the breaking in period extra, and sometimes seemingly unnecessary, analyses should be made. Together with the analyses, a proper routine of sampling should be established so that the data secured is truly representative of actual operating conditions. In this connection, composite samples, even though not taken every day, are better than a larger number of grab samples.

Records

A good operating log is invaluable. In the beginning even seemingly trivial observations should be entered. Also, daily or weekly running charts should be kept so that day-to-day comparisons can be made readily. During the breaking in period particular attention should be paid to detail so that a decision can be made as to what informa-

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tion is important and what can be eliminated or reduced.

Procedure

The breaking in period is the time to experiment with changes in treatment plant operation and, if necessary, with production changes and scheduling to get the best and most consistent operation of the waste treatment plant. Regulatory authorities are reasonable people; they do not expect that a treatment plant will function immediately at maximum efficiency. However, they do expect that operating procedures for satisfactory performance will be established in a reasonable length of time. Therefore, the time for experimentation is during the breaking in period.

Cooperation

The patience and cooperation of management is an absolute necessity. For success, waste treatment must be considered by management to be just as important as any other phase of the production process and money must be made available for necessary experimentation and changes. After all, it is possible for production to be limited, or even stopped, by a failure of the waste treatment process.

Time

When the waste treated is highly concentrated so that maximum efficiency must be obtained at all times to meet effluent standards, a year is none too short a time to allow for the breaking in period; an even longer period may be necessary. This seemingly long period is required to determine the effect of seasonal changes on plant operation and variations in waste loads. Just as important, time is required to develop operating techniques to cope with all such variations.

General Problems

To point out why the breaking in period of a plant treating a concentrated organic waste may be so complicated, some of the differences between such treatment and ordinary sewage treatment are considered.

For such a plant the effluent requirement may be 35 p.p.m. B.O.D., as it is for the Dreyfus plant. The raw waste B.O.D. varies from 1,500 to 2,000 p.p.m., so that to meet effluent requirements a consistent 98 per cent reduction of B.O.D. must be maintained. In complete sewage treatment, with a starting B.O.D. of 200 p.p.m. and effluents as low as 10 to 20 p.p.m., ordinary operating procedure requires only 90 to 95 per cent B.O.D. reduction. The operator of an activated sludge plant would consider himself a "world beater," and rightly so, if he could always obtain an effluent of 4 p.p.m. B.O.D., which would be 98 per cent reduction. Such results are considered only routine for the operator of an industrial waste treatment plant and absolutely necessary if the effluent requirements are to be met.

Percentage reduction figures are misleading when it comes to evaluating waste or sewage treatment results; it is well-known that it is much easier to go from 80 to 81 per cent B.O.D. reduction than it is to go from 95 to 96 per cent reduction. For complete waste treatment, 90 per cent B.O.D. reduction can be considered routine, a good plant can almost do that by itself; but from 90 to 95 per cent reduction the operator has to work, and from 95 per cent on up the operator has to fight.

Consider what happens to an activated sludge effluent when the B.O.D. efficiency drops from 95 to 90 per cent; the effluent rises from 10 p.p.m. B.O.D. to 20 p.p.m. B.O.D. and no one outside of the operator and the State Health Department realizes anything has happened. The operator can shrug his shoulders and say, "Well, let's see if we can find out what happened." However, if an industrial waste treatment plant with a 2,000 p.p.m. B.O.D.

waste suddenly drops from 98 per cent to 93 per cent efficiency, the effluent goes from 40 p.p.m. to 140 p.p.m. B.O.D. Something similar to untreated sewage goes into the stream; everybody nearby will be able to see or smell the difference, and the operator is in trouble.

L. A. Dreyfus Waste Treatment Plant

A brief description of the L. A. Dreyfus plant for treatment of natural gum wastes and some of the operating results for the first year or breaking in period are of interest. Because of some unusual difficulties, the plant is not completely broken in as yet, although the personnel have worked hard to get up to the 95 per cent efficiency mark and are now ready to begin the fight for higher efficiencies.

The plant handles about 20,000 g.p.d. of 1,500- to 2,500-p.p.m. B.O.D. waste from the washing of all types of natural gums from all parts of the world. Most of the organic load is soluble and the waste has only about 400 p.p.m. suspended solids, consisting mostly of gum particles, which have a low oxygen demand. In addition, about 8,000 g.p.d. of domestic sewage is treated by the plant. This sewage has a B.O.D. of about 240 p.p.m. The flow diagram of the plant is shown in Figure 1; a general view, in Figure 2.

The plant was put into operation about December, 1948, and consists of the following units:

1. Two 30-ft. diameter by 20-ft. deep digesters; 200,000-gal. total capacity.
2. One 12-ft. diameter by 8-ft. deep settling tank, receives digester effluent, domestic sewage, and trickling filter recirculation; 6,700-gal. capacity.
3. One 30-ft. diameter by 4-ft. deep recirculating trickling filter; 100 cu. yd. capacity.
4. Two sand beds each 38 ft. square; 1/16-acre area; original installation.
5. Final chlorine contact tank providing 1-hr. detention.

When the plant was built, there was every reason to believe that within one year the load would be cut consider-

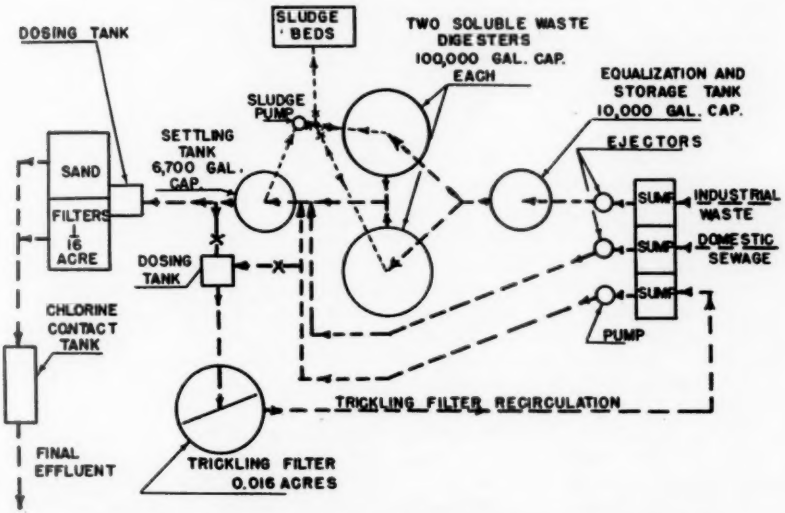

FIGURE 1.—Flow diagram of L. A. Dreyfus gum waste treatment plant.

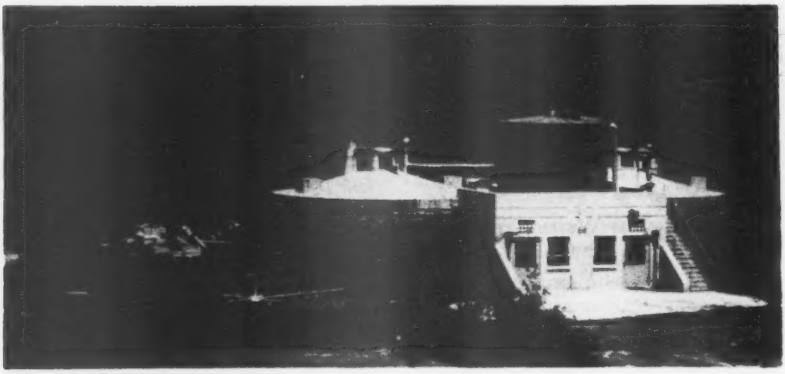

FIGURE 2.—General view of gum waste treatment plant as constructed.

ably because of some contemplated formula changes. Unfortunately, for reasons beyond the company's control, this has not been realized.

Because of this the company in good faith requested certain design allowances, which were granted by the State Department of Health. Accordingly, the plant was designed with a single settling tank, which is rather unconventional for this type of treatment plant. It was felt that the trickling filter would not be necessary once the load was reduced and that one settling tank would be sufficient. Also, only two sand beds were originally constructed, and no provision was made for series operation of the digesters.

Operational Difficulties

The process water used is a very hard well water containing about 900 p.p.m. sulfates. These sulfates are reduced to sulfides in the digester. Consequently, there is a considerable odor problem involved in the aerobic treatment of the digester effluent. About one-half the sulfides are removed as hydrogen sulfide in the digester gas and burned. The remaining sulfides are in the digester effluent and run about 150 p.p.m., of which approximately 25 per cent is free hydrogen sulfide. At the present time odor control is being obtained by treating the digester effluent with about 1,000 p.p.m. chlorine, or 80 per cent of the chlorine demand.

In addition to the hydrogen sulfide problem, there was no effluent from the sand filters for the first two or three months. Only when full operation was commenced was it discovered that the underdrains were almost completely clogged with sand. At first, the underdrains were dug up and protected with fine gravel and paper covers over the joints; later it was found necessary to dig up one entire bed and replace all the gravel and sand. Following this, two new sand filters were constructed, one of which is in operation and the other is nearing completion.

Breaking In Data

Figure 3 shows the average monthly operating data for B.O.D. loads on the various units, together with the industrial waste flows. It is of interest that the waste flow curve and the p.p.m. B.O.D. curve follow the same general trend. This is similar to what occurs during any given day at a plant treating domestic sewage. The relationship is caused by the fact that gums, like many other natural products, are not uniform in character. If a large ship-

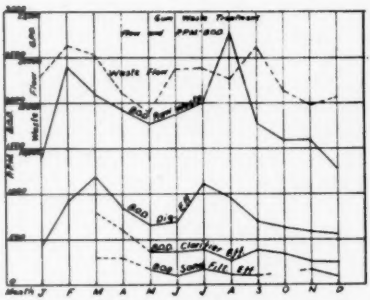

FIGURE 3.—Average monthly operating data on gum waste treatment.

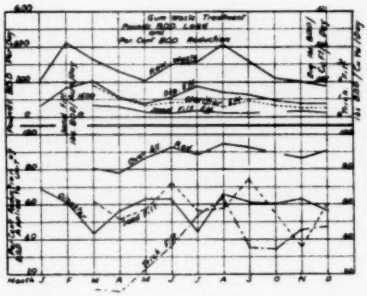

FIGURE 4.—Average B.O.D. loading and reductions of gum waste treatment plant units.

ment of gums happens to contain an abnormal amount of foreign material, it naturally takes more water to wash it clean. The water use does not rise in proportion to the material to be removed, hence a rise in concentration with a rise in waste volume.

The peaks in the digester effluent B.O.D. curve are caused by two factors —an increased load, and a loss of sludge. In both instances, the B.O.D. reduction in the digester was brought back to a normal 60 per cent by the addition of digested sewage sludge. The data for the clarifier effluent and the sand filter effluent are complete, starting in May. The values for March and April are taken from a few samples and are shown to indicate trends. Figure 3 shows a considerable difference between the p.p.m. B.O.D. of the digester effluent and the clarifier effluent. It must be remembered, that domestic sewage is added to the clarifier which reduces the p.p.m. B.O.D. of the incoming waste.

Figure 4 shows the pounds B.O.D. load on the various units, together with values showing the common loading factors. At the bottom is shown the per cent B.O.D. reductions between the influent and effluent of each unit and also the over-all plant B.O.D. reduction. The clarifier and trickling filter are considered as a single unit and efficiency figures given are computed by difference and not calculated from actual analytical tests. The data are briefly summarized in Table I.

TABLE I.—Average Results of Operation, May to December, 1949

Flow, process waste (g.p.d.)	17,160
Flow, domestic sewage (g.p.d.)	8,000
Flow, total (g.p.d.)	25,160
B.O.D., process waste (p.p.m.)	1,838
B.O.D., digester effl. (p.p.m.)	741
B.O.D., reduction by digester (%)	60
B.O.D., domestic sewage (p.p.m.)	240
B.O.D., clarifier influent [1] (p.p.m.)	582
B.O.D., clarifier effluent (p.p.m.)	327
B.O.D., reduction by clarifier and trickling filter (%)	44
B.O.D., sand filter effluent (p.p.m.)	129
B.O.D., reduction by sand filters (%)	60
B.O.D., over-all reduction including domestic sewage (%)	90.1

[1] Digester effluent plus sewage.

Proposed Improvements

To improve the operation and endeavor to obtain 98 per cent B.O.D. reduction, certain changes in operation are contemplated:

1. City water low in sulfates will be used for process water.
2. Four sand beds will be put into operation.
3. The digesters will be arranged for either series or parallel operation.

Summary

The "breaking in" of an industrial waste treatment plant providing complete treatment for a concentrated

waste is usually a long process requiring diligent attention and considerable effort. Usually there is no easy road to success, but time, hard work, cooperation, and money are required to get the operating procedures standardized and to secure the ultimate in efficiency.

Acknowledgment

Acknowledgment is made to the management of the L. A. Dreyfus Company for their cooperation in making this presentation possible, and also to A. Scocco, the plant operator, for his help and advice.

TIPS ON WINTER OPERATION

By Roy Binder

Superintendent, Sewage Treatment Plant, Hays, Kansas

There are several different types of sewage treatment plants. Therefore, this short article cannot cover all of the problems arising in all types, although an effort is made to cover most of them.

First, the year is divided into two seasons—summer and winter. The summer months at a sewage treatment plant constitute a long busy season, starting in April and continuing through November. For good winter operation certain types of work must be done in the summer; that is when preparation for winter begins.

Sewage plant operators have learned that it pays to keep a sewage treatment works in a tidy and neat condition. Is it not better for the citizen to find a park where he expects only a sewage plant, than to find a sewage plant where he expected to see only a park? Therefore, shrubs, trees, well-kept lawns, roads, and walks require care. Concrete work, whether in buildings, tanks, roads, or walks, should, if possible, be done in the summer months. The cleaning of boilers, heaters, or any other heating units should be done in warm weather, when heat requirements are lowest.

Adding new sand to the drying beds, repairing and painting of all outside machinery, making oil changes, etc., can be done much easier in the summer months than when it is 10° below zero. Digesters should be worked hard during the summer months so they are pretty well emptied by the end of November for winter storage. By doing this, in most cases, very little sludge will have to be drained during the winter months, when withdrawal is difficult and sludge drying slow. With the summer season over, we are now ready to begin the winter season with its ice, snow, and cold.

The lawn mowing is over until the next year. The boilers and other heating units are ready for their winter operation. All outside work, such as concrete tanks, walks, the sanding of drying beds, repairing of machinery, oil changes, etc., has been completed. Then why worry about the cold? Most outside work has been done and attention can be given to inside work. First, there is the painting of the inside of buildings, and of floors, piping, machinery, motors, etc. With that finished, pumps and motors are overhauled, installing new bearings if needed, changing oil in the different machines, etc. By the time all this has been completed, summer has returned, and with all the inside work done there will be many more days to add to the busy season.

Gas and Sludge

Getting back to winter operation problems again. In digesters with fixed covers, or where water is used as a gas seal, the water must be drained

out and replaced with alcohol or some other anti-freeze unless the digesters are heated. During the winter months, all valves, seals, and manhole covers should be checked for gas leaks. A small leak can mean loss of heat if gas is used for heating. Always use a soap solution in testing for gas leaks—matches cause explosions.

There has been some trouble in the withdrawal of sludge to the drying beds during winter operation. Be sure all lines have been flushed out and properly drained to prevent freezing. After sludge is withdrawn to the drying beds, the lines should be flushed out and the valves left open part way at each drying bed. Otherwise they will freeze and be inoperable when needed again.

Trickling Filters

Winter operation of trickling filters has caused more trouble than any other unit and requires more attention. During cold weather it is necessary to prevent pipes and nozzles from freezing. Providing bleeder valves in the distributor piping is usually sufficient. Nozzles that become clogged ought to be cleaned as soon as possible, otherwise they are liable to freeze. Snow and ice must not be permitted to accumulate on the filter stone to such an extent that the distributor arms will not rotate. Winter troubles resulting from ice formations at the center column of the distributor can be eliminated by plugging the openings nearest the center of each arm. If a dosing tank is used to apply sewage to the trickling filters, the dosing chambers should be cleaned of accumulations of grease, slime, and leaves once a week. If these accumulations are not removed, they will be sucked into the distributor piping, the nozzles will become clogged, and freezing will result.

SEWAGE RECLAMATION AT GOLDEN GATE PARK

By Benn Martin

Superintendent, Golden Gate Park Sewage Treatment Plant, San Francisco, Calif.

The sewage treatment plant in San Francisco's Golden Gate Park is a secondary treatment plant using the activated sludge process preceded by primary treatment, which consists of screening, grit and grease removal, and plain sedimentation. There are manually cleaned bar-racks, a by-pass to a sewer which crosses the park, a grit chamber, a flash aeration tank for grease removal, two rectangular primary settling tanks operated in parallel (by a structural change effected in 1949), two aeration tanks operated in series using spiral flow and tapered air distribution, and one rectangular final settling tank. This is followed by a contact tank for final chlorination. There are also two digesters and four drying beds, although these are not in use.

At the design capacity of 1 m.g.d. the detention period in the primary sedimentation tanks is somewhat more than 2 hr. In the aeration tanks the detention period is approximately 8 hr. The final settling tank has a detention period equal to that of the primaries; the chlorine contact tank provides a minimum period of 20 min. for disinfection.

Actually Water Treatment Plant

The plant is unique in that it is situated between a sewer and a sewage treatment plant (Richmond-Sunset plant), and present operating policy makes full use of the advantageous position. All screenings, grit, and grease are washed through the by-pass into a sewer connected with the sewage treatment plant that normally treats

the sewage of the contiguous area. Raw sludge, which is drawn from the primary sedimentation tanks at 2-hr. intervals, is sent with sufficient wash water into this same line. The excess activated sludge also is wasted into this sewer. Thus, all problems normally associated with the disposal of solids are non-existent. This permits all activity and personnel effort to be directed toward the production of effluent for use in the irrigation system of the park.

Until 1947, the plant effluent was used solely for maintaining the level of various lakes in the park. After July of that year, the installation of a pump and discharge line on the shore of Elk Lake, which is now used as the plant reservoir, make it possible to pump effluent directly into the irrigation system and Stow Lake, or the park reservoir atop Strawberry Hill. Here, in addition to the distribution system directly connected to the reservoir, it is possible for a limited amount of plant effluent to enter the line leading to the waterworks and be pumped, along with well water, into the northeast areas of the park. These arrangements make plant effluent available for irrigation in all areas of the park except that one served by the domestic supply. This latter has a separate system.

The plant effluent is derived from a sewage which is almost entirely domestic. Suspended solids are 250 p.p.m., with a B.O.D. of 350 p.p.m. After primary treatment the settled sewage has a suspended solids content of 50 p.p.m. and a B.O.D. of 150 p.p.m. After secondary treatment, both the B.O.D. and the suspended solids are less than 5 p.p.m. in samples taken from the final settling tank.

Chlorination is carefully controlled, and a residual of 2 p.p.m. after the full contact period is maintained. An inspector from the Department of Public Health samples the water routinely. The plant effluent meets drinking water standards.

Costs

The cost per 1,000-gal. unit of effluent at the plant is $0.07. Gravity flow is sufficient to maintain those lakes which are at a lower elevation. For irrigation purposes, and for maintaining the level of Stow Lake, where a boating concession has been established, effluent must be pumped from the plant reservoir. The cost of pumping is $0.04 per 1,000 gal. These costs compare with a cost of $0.22 per 1,000 gal. for irrigation water taken from the distribution system of the domestic supply. Cost data, where indicated, were taken from a survey based on the 1948–1949 water production. Included in the annual operating cost was the total of certain capital improvements made during that fiscal year.

TIPS AND QUIPS

Famous Boat Trip

News of the death on November 24, 1950, of Reuben F. Brown, superintendent, Sewer Maintenance Division, City of Los Angeles, Calif., recalls his daring 6-mi. boat trip through the city's outfall sewer from Inglewood to the sea. Attired in a rubber suit and gas mask, and using all rubber covered equipment to prevent sparking in the explosive sewer atmosphere, Brown spent a few hours in the sewer line every day for six weeks. During the trip he found several breaks in the huge pipe. As a result of his subsequent report, thousands of dollars were expended on repairs, including construction of a thick concrete blanket over the outfall.

At the time of his death and for several years prior Mr. Brown was chairman of the Federation's Manual Subcommittee on Sewer Maintenance. He is succeeded in the Sewer Maintenance Division position by Alvin A. Appel, acting superintendent during the past year, whose post as assistant superintendent has been filled by James L. Carey.

Civil Defense Book

The Federal Civil Defense Administration has issued a 260-page book on "Health Services and Special Weapons Defense" outlining the functions, responsibility, and organization of the civil defense health services. The material presents functional needs, rather than an administrative blueprint.

Among the items of interest to local sanitation personnel are the following:

1. Sanitation authorities would have to be prepared to advise on temporary improvised methods of sewage disposal in case of damaged hospital sewer lines or loss of water supply.

2. Bombing of cities might seriously disrupt sewerage systems or water supplies. Emergency methods of handling wastes and repairing damaged facilities must be planned in advance. Planned warning systems to downstream cities should be established where emergency diversion of polluting wastes to natural watercourses becomes necessary.

3. Water contamination by radioactivity would be small from a high air burst of an atomic bomb. However, a surface or underwater burst might produce heavy water supply contamination, precluding use of the affected water for some time, even with normal treatment.

4. Residual radioactive contamination may contaminate the ground and ground waters in areas of sewer damage by ground bursts. Treatment plants would be subject to the same hazards as other structures. However, the wastes carried by sewers and treatment plants would carry varying amounts of radioactivity, which would tend to concentrate in the slimes involved.

The book (publication AG–11–1) is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at a price of $0.60.

Eager Beavers

The fur-bearing animal business seems to be picking up in fine shape—to the dismay of sewage plant operators. In a recent "Corner" (p. 251, February, 1951) we carried an item about a mink in a cellar drain; but now it's beavers in the outlet stream!

According to the *Official Bulletin* of the North Dakota Water and Sewage Works Conference, the municipality of Powers Lake, N. Dak., has been having trouble with beavers building dams and impounding the effluent from the sewage treatment plant. During the warmer months, considerable odor nuisance is reported from this ponding.

Normally, the State Fish and Game Department would remove beavers creating such conditions. In this instance, however, a permit already had been issued to the landowner to trap the beaver, so complete removal had to await the end of the trapping season!

Gas Leakage to Sewers

A timely hint that may well be passed along to your local fire department and utility company is the warning note contained in a recent issue of *Health*, the bimonthly bulletin of the Wisconsin State Board of Health, as follows:

"When an explosion occurs in a community and high gas concentrations are found in the sewers of the surrounding area, there should be an immediate flushing of these sewers with air and this flushing should be con-

tinued until the source of the gas leakage is located and eliminated. This action should not be delayed while waiting for the results of gas analysis. The fact that one building in the area has already been destroyed would certainly indicate that other explosions could take place as long as high gas concentrations are permitted to remain in the sewers. Fire departments and/or utility companies should be equipped with high-capacity portable blowers driven by explosive-proof motors. Such blowers would be a great help in flushing explosive mixtures of gas and air from the sewers.

"It would be well if all fire departments were equipped with some type of combustible gas indicator; then the basements and sewers in a disaster area could be immediately checked and remedial steps taken to prevent further damage. After all, explosions and fires are one and the same thing except that the combustion rate is faster in one case than in the other. Another very useful instrument for fire departments to have is a carbon monoxide tester. Manufactured gas or gas from any form of incomplete combustion can be easily detected with a carbon monoxide tester because these instruments are simple to operate and to read.

"In towns or cities that have had gas explosion from the presence of gas or combustible vapors in the sewers, it would be wise to have the entire sewerage system checked at regular intervals by removing manhole covers and checking for the presence of gases with a combustible gas indicator. This method may not afford complete protection from these explosions, but it will materially reduce the possibility of repeated explosions. The cost of this protection is not prohibitive."

Popular (?) Boat Trip

Tourists in Paris can now take a boat trip in the city's sewers, according to a recent item in *Engineering News-Record* (Dec. 14, 1950, p. 12). Tourists pay about 5¢ to the sewerman, descend a winding iron staircase, and find themselves in a stone-arched gallery. A small motor boat waits on the stream of polluted water, which is about 11 ft. wide and 3 ft. deep. The arched ceiling is 10 ft. above water level. An occasional miniature drawbridge spanning the sewer opens up as the boat chugs upstream slowly from the Madeleine to the Place De La Concorde, beneath the famous Rue Royale.

For any operator planning a trip abroad this is certainly a "must" on his sightseeing itinerary!

CHLORINE ORDERS

National Production Authority Order M-31, assuring chlorine consumers the same amount as used during 1950, contains a specific requirement that all orders for chlorine for "purifying water for human consumption and use, or of treatment of sewage, where the use of chlorine is essential to public health" be certified. On all orders for delivery after March 1, 1951, there must be written or typed on the requisition, order, letter, postcard, etc., sent to the supplier the statement:

"Certified under NPA Order M-31"

For new users of chlorine, or where the 1951 requirement is greater than the 1950 use, if trouble is experienced in securing sufficient chlorine the complete facts in the case should be addressed to the Chemical Division, National Production Authority, Washington, D. C., with a request for a determination of the case on its merits.

Federation Affairs

REPORT OF COMMITTEE ON CHLORINE SUPPLY

January, 1951

Pursuant to the action by the Board of Control at the October 12, 1950 meeting, your committee transmits herewith its findings and conclusions to the President and Executive Committee.

The committee members individually and collectively have held personal interviews and conducted correspondence with many interests, and have met with major chlorine producers in an attempt to determine and evaluate the factors involved in the unsatisfactory situation with respect to availability and distribution of chlorine for sewage treatment purposes.

The committee finds that there are a number of causes underlying the difficulties which the consumer in the field of sewage treatment has been experiencing. The following are considered to be the most important:

1.1. The production capacity of the chlorine industry has not kept pace with increased demands in recent years and a shortage now exists. Expansion of production facilities is now underway.

1.2. The desire on the part of certain producers to terminate their sales to municipalities in favor of more attractive and lucrative business with other classes of consumers. This stems primarily from, (a) a more uniform and stable outlet for chlorine in industrial fields that is afforded by municipalities by the very nature of the requirements of each, (b) the unfavorable purchase practices encountered in municipalities in comparison with those of industry. Complicated contractual requirements, variations in performance bonds, special conditions of contracts and the absence of loyalty to supplier, which is the outgrowth of purchasing by the rule of low bidder must be awarded the business, have been indicated as not conductive to favorable sales relationships with municipalities.

1.3. The placing of restrictions by the supplier on the size of container he will furnish, making it necessary for the sewage plant to accommodate its operations to 150 pound cylinders when it has been designed and equipped to utilize ton containers. The reasons given for such restrictions are the high capital cost of the ton container in relation to the fluctuating or seasonal demand, the shortage of steel to fabricate the larger container, and the time consumed in using the contents and holding containers out of circulation for uneconomical lengths of time. These are cost considerations, plus the nuisance of recovery of containers from users who have changed suppliers because of minor price advantages.

1.4. The disruption of production during strikes. No provision has been made for continuing production of chlorine for essential health services as represented by the water purification and sewage treatment field, similar to arrangements in effect for continuing the supply of milk and power under these conditions. During the strikes of 1950, however, chlorine has in some instances been supplied customers of struck plants by other chlorine producers.

The following developments have transpired since the October meeting:

2.1. The committee has been told that all but one or two chlorine producers have issued directives to their sales departments that chlorine for sanitation needs are to be met in full and without reservations.

2.2. On December 6, 1950, the committee conferred in New York with officials of two major companies (both member companies in The Chlorine Institute, Inc.) and reviewed the problem and explored prospective methods of relieving the situation in the future. We were informed that the question of assured supply for sanitation was the subject of a conference be-

tween representatives of the alkali-chlorine industry and the National Production Authority of the U. S. Department of Commerce on the previous day. An order is now being formulated by NPA controlling chlorine distribution. We are advised that provision will be made to meet water and sewage treatment needs to the extent that these operations are assured chlorine in no less quantity than that used in 1950. (NPA order M-31, issued January 24, 1950.)

2.3. The prospects of forming a joint committee, composed of representatives of the Federation of Sewage and Industrial Wastes Associations, the American Water Works Association, the Conference of State Sanitary Engineers, and the Chlorine industry have been explored. The value of such a committee would lie in developing an outline of recommended practice in the interest of both producer and consumer and in assisting in solving problems of distribution and availability.

The conclusions reached by the committee to date are:

3.1. It appears that the committee can accomplish nothing further at this time toward assuring an adequate supply of chlorine for sewage treatment, inasmuch as allocation and distribution is to be placed under government control and assurance has been given that adequate provision, considering the present national emergency, can be expected to be made by the NPA in its forthcoming chlorine industry order.

3.2. The problem of container sizes furnished to sewage plants has not been resolved. The difficulties here are largely concerned with cost of the one ton containers. Current criteria are varied but have been based primarily upon a limiting total annual consumption of chlorine by the sewage plant. Maximum daily rates of chlorine comsumption in sewage treatment need to receive consideration if handling, consumption, and storage of chlorine in small containers is to be kept within practical and reasonable limits. The answer appears to lie in establishing a price on chlorine in ton containers which will insure a fair return to the supplier while permitting the sewage treatment plant to secure a container size which can be conveniently and practically utilized. In view of the dislocation of the industry occasioned by the present national emergency and the controls about to be imposed by government order, it appears inopportune for us to pursue this phase of the problem further at this time. The user undoubtedly will find it necessary to negotiate the container size with the individual supplier as long as emergency controls remain in effect. This question, however, remains critical and efforts to clarify the matter should be resumed at the earliest possible date that is appropriate.

3.3. It is believed that action to insure a supply of chlorine during strike periods is in order and is an appropriate matter to be considered by agencies of the federal government, specifically the U. S. Public Health Service and the U. S. Department of Labor. It is therefore suggested that the Executive Committee transmit a copy of this report to these agencies seeking their assistance.

3.4. The factors involved in the unfavorable purchase practices cannot be rectified immediately or readily. It appears that an approach can best be made by transmitting this report to the Federation membership, directing their attention to the practices mentioned with the recommendation that they promote the development of improved practices through their contacts with procurement officials and suppliers.

L. F. Oeming, *Chairman*
L. H. Enslow
L. L. Hedgepeth

Reviews and Abstracts*

Hydrographic Factors Involved in the Dispersion of Pollutants Introduced Into Tidal Waters. By B. H. Ketchum. *Jour.*, Boston Soc. Civil Eng., 37, 3, 296 (July, 1950).

This contribution, No. 515, from the Woods Hole (Mass.) Oceanographic Institution discusses the characteristics of circulation of tidal waters, the use of salinity-temperature-depth recorders, and the distribution of salinity in the New York Bight, by using the river water as a tracer and studying the salinity distribution. The standard salinity chosen was that of a station located about 25 miles east of Sandy Hook and 10 miles south of the Long Island shore. The flushing time for the river water to move through the surveyed area is derived by dividing the total volume of river water in the area by the river flow. This varied from 6.0 to 10.6 days. There is also a non-tidal drift, which varies from 1.0 to 4.4 miles per day in one range.

A brief discussion is given for Raritan Bay.

The author urges the value of a hydrographic survey in evaluating the ability of tidal waters to disperse introduced pollutants and in selecting the location for the point of dispersal.

Langdon Pearse

Composting for Disposal of Organic Refuse. Tech. Bull. No. 1, Sanitary Eng. Research Project, Univ. of California. 42 pp. (July, 1950).

This bulletin discusses the nature of composting as a biological method of altering the composition of organic material, particularly garbage, into a stable humus-like end product, by accumulating the raw materials in a mass which ferments and generates heat. Mixing is essential. Very few American cities have employed or even considered composting, although it appears to be an ancient practice. In the United States, composting is chiefly used on a small scale in gardens.

Various processes are described (such as the Indore, Beccari, Verdier, Frazer (Eweson), Earp-Thomas, Dano, and others), some of which have been before the public for 30 years or more. (Most of these have been and are in a promotional stage, stimulated by the writings of Sir Albert Howard, who apparently disregarded the economic side of the problem.)

The bulletin describes the various procedures, but is not critical on the value of the procedures and the lack of successful demonstration by disinterested authority. The authors state that the economics of composting depend on the cost of the composting and the sale value of the reclaimed humus. However, analyses are lacking for the resulting material, although the authors conclude it is similar to digested sewage sludge, which is a soil conditioner and not a fertilizer.

The report illustrates the status of composting in the United States at this time and is of value for reference purposes in analyzing promotional developments.

Langdon Pearse

Some Applications of Oceanography to Engineering Problems. By A. C. Redfield. *Jour.*, Boston Soc. Civil Eng., 37, 3, 275 (July, 1950).

This contribution, No. 514, from the Woods Hole (Mass.) Oceanographic Institution discusses navigation, communications, hydrographic study, protection of shore lines and shore-line structure, petroleum engineering, chemical engineering, power development, and sanitary engineering from the viewpoints of the effects on these fields by tides, currents, and other ocean factors.

Langdon Pearse

* Please send to Federation headquarters all periodicals, bulletins, special reports, etc., which might be suitable for abstracting in This Journal. Publications of public health departments, stream pollution control agencies, research organizations, and education institutions are particularly desired. Address such material: Federation of Sewage and Industrial Wastes Assns., 325 Illinois Bldg., Champaign, Ill.

Auckland Metropolitan Drainage Board Annual Report for the Year Ending June 30, 1950. By J. P. Porter. 10 pp., mimeo.

This report describes the problems confronting a Board which handles a population of 257,760 (as of April 1, 1949) in New Zealand. Various features of the scheme approved by the Drainage Commission are being explored; namely, location of sewer; exploration of route of submarine outfall, with the aid of a geologist to determine location of sound rock; tests of sewage treatment in pilot plants, to ascertain value of flocculation of raw screened sewage; use of tanks of smaller capacity for aeration; purification of mixtures of sewage and packinghouse wastes in single-stage or two-stage oxidation plants; and digestion and air-drying of sewage sludge. The operation and maintenance of existing works (chiefly screens with ½-in. opening and grit chambers) are described. Trade wastes are being examined. The current revenue from taxes is about £79,392 (Australian). The outstanding debt is about £487,646 (Australian), which is being retired by a sinking fund.

Langdon Pearse

Throw Your Wastes Down a Well. By James A. Lee. *Chem. Eng.*, **57**, 9, 137 (Sept., 1950).

The disposal of wastes from chemical plants is a problem of considerable magnitude and waste disposal by means of special disposal wells offers a possible solution to certain industrial waste problems. For 20 years oil brines have been successfully returned underground via deep wells. Disposal wells should always be drilled into a porous rock formation in which the water present is not suitable for any known use. Permission to dispose of wastes in this manner must be obtained from state regulating agencies.

Experience has indicated that the use of several small wells is better than one large one. Wastes must be clear and chemically stable to avoid plugging the porous rock stratum. Wells which have become clogged may be restored by acidizing or by a special backwashing technique employing high-pressure gas.

On the Gulf Coast, the cost for a 4,000-ft. completely equipped well is about $10 per foot. Operating costs for brine disposal wells are about 1.5¢ per barrel.

Recently, protective coatings of phenolic-formaldehyde resin have been used for piping, fittings, etc., in preference to cement linings where brines are handled.

Paul D. Haney

Preventing Stream Pollution from Oil Pipeline Breaks: A Guidebook of Recommended Practice. Ohio River Valley Water Sanit. Comm. (Sept., 1950).

Oil pipeline breaks not only cause economic loss, but also may result in serious stream pollution. There is no uniform practice for handling these emergencies, and the Commission has prepared a guidebook of recommendations derived from many sources.

Prevention of breaks depends on careful design and sound construction. The proper kind of pipe; expert welding of joints; protection of stream crossings; adequate cover on cultivated land; provision of surge-relief valves; and protection against corrosion (probably the most important cause of leaks and breaks) are essential considerations. Breaks can often be prevented by prompt repair of damaged pipe disclosed by routine inspection.

In spite of preventive measures breaks occur, and early detection is prerequisite to prompt action. A continuous material balance by transmitting flow meters and automatic gages will provide significant information. Pumps should be stopped whenever there is a drop in line pressure, and this is best done with automatic equipment. Pumping stations may be 50 miles apart, and effective communications are necessary to locate a break promptly. Exact locations may be made by walking the line, or using autos or airplanes. Signs at road crossings giving the company name and telephone number are helpful in locating breaks.

When a break occurs, an emergency squad of skilled men, properly equipped and directed, must be dispatched at once if excessive loss and damage are to be prevented. Large-scale county maps showing locations of all lines, valves, roads and streams are helpful in moving repair crews and adequate equipment to the site. State pollution control agencies should be notified at once to permit them to inform operators of water supplies that might be

affected and to aid in pollution control measures.

Except where small quantities or light distillates are involved, impoundment of escaped oil is essential for recovery and minimizing damages. Where the oil has not reached a stream, a dike should be thrown up or a sump dug. If the oil has flowed to a small stream, an earth dam can be thrown across to trap the oil, and the water can be discharged through subsurface pipes. In a large stream, one or more floating booms should be placed to catch the oil. After the oil has been impounded it may be recovered by pumping to tank trucks, or back into the line when repairs have been made. Portable centrifugal pumps of 100- to 150-g.p.m. capacity have been found useful for recovery in tanks; for return to the line, high-pressure pumps are needed.

After recovery operations have been completed, oil residues should be burned with suitable precautions. If heavy oil is involved, burlap, hay, or sawdust should be provided to absorb the oil and facilitate burning.

Companies using airplanes for routine inspection say they are invaluable during times of emergency. Adequate two-way radio equipment for planes, autos, or line walkers is essential for satisfactory communication. Repair equipment will vary considerably, and crews should be familiar with the terrain traversed.

RICHARD D. HOAK

The Textile Industry and Stream Pollution. By J. A. McCARTHY. *Am. Dyestuff Rep.*, **39**, 22, 732 (Oct. 30, 1950).

The author reviews the general stream pollution problem in New England with particular reference to the textile industry. In Massachusetts alone, material with B.O.D. discharged annually by woolen and worsted mills approximates 30,000,000 lb. from wool scouring, 5,000,000 from dyeing, 2,000,000 from finishing, and 3,000,000 from other operations. This material would require, in the absence of reaeration or waste treatment, some 1,600,000,000 gal. of stream water per day for assimilation without nuisance, which would amount to 0.1 to 0.25 of the daily average rainfall reaching streams in Massachusetts. As rainfall and wastes are not uniformly distributed, there are areas of high pollution.

The interstate aspects of pollution abatement were recognized with the establishment of the New England Interstate Water Pollution Control Commission, which divided New England streams into four classes according to the highest intended use. The major attention of pollution abatement programs is being given to those parts of streams whose quality is below the lowest class established.

In discussing methods for dealing with textile wastes, equalization and sedimentation are suggested as expedients that may provide a satisfactory solution, but such methods must not be adopted without careful study. An instance is cited in which a plant survey resulted in reducing water use by 50 per cent and saved much wasted heat. An important result of sedimentation is removal of suspended material containing B.O.D., thereby avoiding sludge banks near sewer outfalls. Sedimentation alone may not provide sufficient treatment; use of chemical coagulants is often required. In general, such treatment is effective only on strong wastes, as the improvement of dilute wastes is usually too slight to warrant the extra expense. Wool scouring wastes have presented problems because of high treatment costs or because the coagulants failed to affect the grease emulsions. The calcium hypochlorite and the calcium chloride-carbon dioxide processes appear to provide satisfactory answers to the problem, but as much as 30 to 40 per cent of the B.O.D. material in wool scouring wastes may be in solution, thus imposing an excessive load on even a large stream. Experiments have shown that degreased wool scouring wastes may be treated on trickling filters to any desired degree of B.O.D. reduction. Similarly, dyeing, finishing, and bleachery wastes can be handled on filters. However, none of these processes is yet perfect, costs are often high, and recovery of by-products is not as complete as possible. Plans are being made to install a miniature wool scouring plant at the Lawrence Experiment Station, where various details of wool scouring and waste treatment can be studied in detail. This investigation should be extremely helpful to the textile industry. RICHARD D. HOAK

Cone for Settleable Solids Determination. By Henryk Przyłęcki. *Gaz, Woda i Tech. Sanit.* (Polish), **24**, 9, 317 (Sept., 1950).

A modified technique is described for the determination of settleable solids without the use of the Imhoff cone (these cones are difficult to obtain and being of glass are easily broken). An 18-mm. diameter brass tube is brazed to the apex of a 1-liter metal cone. The cone is attached to a graduated cylinder by means of a rubber stopper. Before the start of the test several graduates are filled with tap water (enough graduates are used to correspond to time fractions used in the determination of the settling curve). One liter of well-agitated sewage is added to the cone and allowed to settle for 5 min. (the settleable solids pass through the tube into the water-filled graduate), after which time a long-stemmed cork or rubber plug is inserted (without agitating the settling solids) to seal off the bottom of the cone. The graduate is removed and placed to one side to permit further settling and a second graduate is attached to the cone; the excess water is discharged from the graduate and no air bubbles remain. The plug is carefully withdrawn and the solids are settled for the next prescribed interval of time. The above process is repeated for each time increment. By means of this procedure the volume of sludge settling out in a given increment of time is determined, and, if desired, the chemical and physical properties of the sludge removed by settling in each increment of time may be studied.

Conrad P. Straub

Waste Gas Liquors as a Source of Nitrogen. By F. Plucinski. *Gaz, Woda i Tech. Sanit.* (Polish), **24**, 268 (July–Aug., 1950).

Waste gas liquors, even though they may contain toxic substances in the form of cyanide, tar acids, concentrations of phenol, etc., should be considered as a source of nitrogen, as they may contain from 1 to 4 per cent nitrogen. Studies show satisfactory results from the use of gas liquor as a fertilizer, although its use on meadow land did not give especially good results. It is suggested that the liquor be applied before seeding in diluted form in an amount depending on its composition, the amount of nitrogen in the soil to be fertilized, and the time of the year. A dosage of 10 grams of nitrogen per square meter of area is suggested, with the waste gas liquor applied after harvest, in winter, or in early spring before seeding.

Undiluted waste gas liquor may be used after harvesting potatoes or winter corn, providing the fields are plowed immediately. Two-fold benefits derive from the use of waste gas liquor in that it inhibits acidity and destroys harmful parasitic organisms and larvae living under the surface of the soil and increases the amount of nitrogen in the soil. Seed should not be sown for two or three weeks after applying the waste gas liquor. The fields may be plowed immediately after application of the material or after several days. Ammonia nitrogen in the liquor can transform to nitrate nitrogen during this time, as it is only in this form that it may be taken up directly by the plants. Fields that are continuously wet and do not drain well become acid; this was usually corrected through the addition of lime. The author suggests that waste gas liquor be used to neutralize or inhibit the acidity. Data are presented which indicate that the use of waste gas liquor containing 1 per cent nitrogen in an amount of 1 kg. N per 1,000 square meters of field increased by 250 per cent the amount of hay harvested. Further data given state that after harvest and addition of one-half the quantity of waste gas liquor used initially the increase in hay yield was 450 per cent that of a non-fertilized field. Other data reported are as follows:

Crop	Yield Increase (%)
Oats, grain	24
Oats, stems	160
Carrots	130
Spinach	250
Cabbage	160
Beets, red	165

The question also is raised as to the use of waste gas liquor as a toxic agent for the destruction of bacteria and parasitic organisms; for example, plant lice, grubs, etc. Taking into account the amount of phenol, naphthalene, cyanides, tar acids, etc., in waste gas liquor, it would be desirable to determine its possible use as a disinfectant for barns, as it may help

decrease the incidence of infectious disease or reduce the numbers of pathogenic organisms present. In addition, waste gas liquor will increase the nitrogen content of manure. The author also suggests possible use of the liquor as a weed control agent on railroad rights of way and in cities.

CONRAD P. STRAUB

Report on Industrial Wastes in the Potomac River Basin. Interstate Commission on the Potomac River Basin. 17 pp. (1950).

This report, for the education of the public, gives a brief historical background and an outline of industries in the basin, together with statistics showing the volumes and population equivalent of wastes discharged by industries as groups and the percentages treated. A list of members of the advisory committees to the Commission is included.

W. A. HASFURTHER

Water Quality Survey of Hampton Roads Shellfish Areas, 1949–1950. Division of Engineering, Virginia State Department of Health, and U. S. P. H. S. Environmental Health Center (Aug., 1950).

The objective of the survey was to determine the improvement in the quality of waters in Hampton Roads shellfish areas since the completion of sewage treatment plants, with a view of removing the restrictions for harvesting shellfish from some of these areas.

The sewered population contributing to tidal waters of the Hampton Roads area increased during the war years. Four primary sewage treatment plants serve approximately 90 per cent of the sewered population. All effluents are chlorinated before discharge. There are, however, still many areas discharging raw sewage or septic tank effluents. In addition, there is discharge from floating population from merchant ships and naval vessels.

Prior to and during the survey the chlorinator capacity was increased and chlorination efficiency of some of the treatment plants was improved by better control.

Extensive bacteriological data show that in most areas within this region the quality of the water has improved substantially and the zones of pollution have diminished, despite the increase in population, chiefly as a result of the installation of sewage treatment facilities.

Studies also were made of the chlorine application, chlorine residuals, and effluent coliform M.P.N. for the various plants. Two of the plants were provided with chlorine contact tanks. At the other two plants reliance was placed on the contact in the outfall. To improve the efficiency of chlorination the point of application was changed to the preliminary settling tanks.

In order to maintain a satisfactory quality of water in the shellfish growing area the proximity of the sewage plant effluent to such an area is taken into consideration. The plant closest to the shellfish growing area should have a median coliform M.P.N. in the effluent not in excess of 500 per 100 ml. for any one month and not more than 10 per cent of the samples shall have an M.P.N. in excess of 10,000 per 100 ml. These results can be accomplished at this plant with pre-chlorination if not more than 10 per cent of the hourly chlorine residuals are less than 0.1 p.p.m. It is recommended that this plant should maintain a residual of 0.2 p.p.m., with no residuals less than 0.1 p.p.m. For plants farther removed from shellfish areas greater coliform M.P.N. in the effluent is allowable.

In view of the improvement in the quality of the water it was recommended that in certain areas the restrictions for harvesting market oysters might be lifted if certain requirements are met, such as the elimination of discharge of raw sewage and maintenance of satisfactory quality of effluents.

H. HEUKELEKIAN

Viability of *Escherichia coli* in Sea Water. BY RALPH F. VACCARO, MARGARET P. BRIGGS, CORNELIA L. CAREY, AND BOSTWICK H. KETCHUM. *Amer. Jour. Pub. Health*, **40**, 10, 1257 (Oct., 1950).

The studies reported in this paper were made because of the bathing beach and shellfish industry problems created by utilization of ocean outfalls for the disposal of sewage, and they were designed to produce information useful in explaining the rapid disappearance of bacteria in the open sea beyond the outfalls. The paper

summarizes the seasonal changes in the bactericidal activity of sea water and the effects on the bactericidal property of sea water of storage, autoclaving, boiling, adding organic matter, pasteurization, and chlorination.

Thirty-seven experiments during a period of slightly more than a year demonstrated a marked seasonal variation in the bactericidal properties of raw fresh sea water. The water was relatively inactive during the winter and most active during the summer. "Correspondingly, the time required for the disappearance of 90 per cent of the introduced *E. coli* population was greatest (6.0 days) in early November and least (0.6 days) in July."

Autoclaving destroyed a large part of sea-water bactericidal activity; boiling for 5 min. resulted in activity between raw and autoclaved. Storage of raw sea water for two weeks greatly increased normal bacterial flora and the result on *E. coli* generally was an increase in bactericidal activity. Addition of organic matter in the form of glucose or peptone did not decrease bactericidal activity as much as autoclaving. Pasteurization at 54° C. for 30 and 60 min. produced results comparable to boiling. Chlorination with 10 p.p.m. of Cl_2 as hypochlorite for 1 hr. was similar in effect to autoclaving.

It is concluded that the most probable cause of the death of *E. coli* populations in sea water is an anti-biotic action requiring the presence of the normal marine flora.

M. R. Golly

Recent Studies on Polluting Liquids in Great Britain. By B. A. Southgate. Centre belge d'Etude et de Documentation des Eaux (Belgium). 5 pp. (1950).

Reference is made to some of the more recent studies and processes developed for treatment of sewage and industrial wastes. Double alternate filtration has been used in the treatment of sewage with filtration rates of 2.91 g.p.d. per cu. yd. and the effluent produced has a B.O.D. of 20 p.p.m. Studies have also been made with rapid sand filtration of sewage at rates of 2 to 3 g.p.m. per sq. ft. The filters are backwashed daily and the backwash water used amounts to 3 per cent of the volume of sewage treated. Gammexane (gamma hexachlorocyclohexane) has been used at a rate of 0.98 lb. per acre for control of *Anisopus* and *Psychoda* filter flies.

In the field of waste treatment and disposal, double alternate filtration has been used in treating dairy and cheese plant wastes. Coagulation with alumino ferric followed by filtration on conventional units has also been used successfully for these wastes. The aerobic retting of flax is mentioned and the author states that this method of reducing the volume of polluting waters should be of interest to the Belgians, as they are the manufacturers of some of the finest linens. Many studies have been carried out for the treatment of metal wastes, including the following: for chromate wastes, reduction with ferric sulfate, precipitation and separation of the supernatant; for wastes containing copper, zinc, and nickel, addition of alkali is suggested, followed by precipitation and decantation; for cyanides, addition of alkali, followed by ferrous sulfate precipitation, and a second process including addition of an alkali followed by chlorination, additional alkali, and separation of the precipitate. It is recommended that wastes containing nickel be treated separately.

Conrad P. Straub

Exploitation of Chlorophyll-Containing Microorganisms in Sewage Disposal. By W. E. Abbott. *Chem. and Ind.* (Brit.), p. 459 (1950).

The photosynthetic activities of chlorophyll-containing organisms in sewage exposed to light increases the D. O., but at the same time increases the suspended solids because of the increase in the numbers of microorganisms. There is at the same time an increase in B.O.D. due to the production of microbial protoplasm, which is more than compensated by the increase in D. O.

The incubation of diluted sewage samples in closed bottles in the dark and light gives a measure of the activity of green organisms. The green organisms stored under anaerobic conditions in the dark lose 20 per cent of their activity as measured by the above method in 4 days, 40 per cent in 7 days, and 66 per cent in 10 days.

Sewage stored in shallow layers (4 in.) outdoors during the summertime with 2- or 3-day detention periods gave an increase

in supernatant liquor after exposure over the initial settled sewage, an increase in suspended solids, organic nitrogen, and a favorable dissolved oxygen balance over the increase in B.O.D. Greenish sludge accumulated in the bottom but did not appear to influence the results except loss of effective volume. Attempts to produce clear effluents free from green organisms and with low B.O.D. were successful when the green organisms were incorporated as a slime adhering to the bottom and sides with as low as one-day contact time. The activity of green organisms converts the soluble forms of nitrogen in sewage to organic nitrogen, which can be recovered.

H. HEUKELEKIAN

Sludge Dewatering by Freezing with Added Chemicals. By G. S. CLEMENTS, R. J. STEPHENSON, AND C. J. REGAN, *Water & Sanit. Eng.* (Brit.), **1**, 7 and 8, 280 (Nov., 1950).

Experiments showed that freezing of primary, digested, and activated sludge improved the dewatering qualities with and without the addition of chemicals. Freezing should be complete. Once completely frozen, the time at which it is kept in a frozen state has little effect. Freezing greatly accelerated the settling of all sludges. The addition of chemicals increased the rate of settling of frozen sludges, but the final volume of sludge produced was the same with and without chemicals. The addition of sodium chloride and sulfuric acid to frozen sludges did not improve the filtration rate, but chlorinated copperas and alum produced striking results. Sodium hypochlorite was ineffective, but high dosages of chlorine were encouraging. The chemicals must be added before freezing. The addition of chemicals after freezing and thawing leads to a much slower rate of settling and filtration. The minimum effective dose of chlorine was 100 to 200 p.p.m. Substantial results were obtained with 100 p.p.m. of ferric iron and 20 p.p.m. of aluminum. The supernatant liquors and filtrates had low oxygen demand. The filter cakes had a solids content of 23 to 30 per cent. They were porous and friable. The filter cake production was 350 lb. per hr. per sq. ft. for digested sludge and up to 70 lb. for activated sludge.

The absolute necessity of complete freezing imposes on the process high power expenditure to withdraw the latent heat of solidification of ice. It requires only 28 B.t.u. to lower the temperature of 1 lb. of sludge from 60° F. to 32° F., but to convert it to ice 142 B.t.u. are required. The economic possibilities would be enhanced if the latent heat is recovered. To accomplish this the latent heat of fusion of one batch of previously frozen sludge was used to cool the refrigerant being circulated to freeze the next. The cooling of the refrigerant was brought about at a low temperature by the continuously melting sludge ice and at the same time thawing the sludge without supplying external heat. A freezing machine embodying this principle was developed. Some approximate cost figures of such a process of freezing the sludge were obtained.

H. HEUKELEKIAN

Third Annual Report for the Year Ending June 30, 1950. New England Interstate Water Pollution Control Commission. 23 pp. (1950).

During the year ending June 30, 1950, New York State became a signatory to the New England Interstate Water Pollution Control Compact, and the Commission established permanent offices in Boston, Mass., following the appointment of an executive secretary. Classification of usage of interstate waters in the Compact area was received from the present signatory states and approved by the Commission as a basis for further action. Cooperative sanitary surveys of several watersheds are in progress.

The report indicates progress in the design and construction of sewage and industrial wastes treatment plants within the New England states, completion of studies on textile wastes, inauguration of studies on other industrial wastes in the Compact area, and progress on various drainage basin pollution reports. Appendices give the Compact in full and the tentative standards for water classification adopted by the Commission.

H. P. ORLAND

Textile Wastes—A Review: 1936–1950. New England Interstate Water Pollution Control Commission. 29 pp. (Dec., 1950).

This critical review of the literature on textile wastes supplements and brings up to date a previous (1936) report of the Textile Foundation. It covers the sources and treatment of textile processing wastes, as well as those from the manufacture of synthetic fibers. A list of 11 particular problems needing further research is included, together with an excellent bibliography of 236 entries.

An appendix containing 10 tables recapitulates representative textile waste data from various other publications, surveys, and studies.

H. P. ORLAND

Rental Charge Expedites Philadelphia's Sewage Treatment Program. By SAMUEL S. BAXTER. *Civil Eng.*, **20**, 7, 40 (July, 1950).

The enactment of a bill authorizing a sewer rental charge enabled Philadelphia to go ahead with its sewerage and sewage treatment program. The article describes in a general way the interception and treatment problem and the units under construction and planned. Details are included for the Northeast works, which was nearly completed and has a capacity of 125 m.g.d.

WM. A. HASFURTHER

Interstate Commission Tackles Pollution Problem in Ohio River Valley. By EDWARD J. CLEARY. *Civil Eng.*, **20**, 8, 32 (Aug., 1950).

The author cites the needs for pollution control in the Ohio River Valley, briefly discusses the formation and authority of the commission, and outlines progress completed or underway to meet the compact's objectives.

WM. A. HASFURTHER

Comprehensive Plant Survey Simplifies Problem of Industrial Waste Disposal. By FRANK W. JONES. *Civil Eng.*, **20**, 8, 34 (Aug., 1950).

The paper points out the need for investigating fluctuations in volumes or quantities, preparation of good flow sheets, separation of sewers, investigation and cataloging of all toxic and noxious materials, making of analyses of all component wastes, training of technical personnel, obtaining good industrial housekeeping, and determining the degree and type of treatment to be required.

WM. A. HASFURTHER

Proceedings of the Second National Public Health Engineering Conference. Bull. Series No. 35, Florida Eng. and Indust. Exper. Sta. (July, 1950).

Several papers were presented under the general theme, "Economics of Sewage Treatment," as follows:

Present and Future Policies of the Bureau of Sanitary Engineering with Regard to the Collection and Disposal of Sewage. By J. W. WAKEFIELD.

A summary is given of the Florida laws which empower the State Board of Health to control planning and operation of sewage and waste collection and disposal. The policy of the Bureau of Sanitary Engineering is given with regard to materials to be used in sewer construction, the methods of treatment of sewage and wastes, and the operation of the resulting plants. Emphasis is placed upon the development of operating data and studies of stream behavior in the Florida region to compare the action with studies made in other sections of the country.

Miami's Sewerage Situation. By RAYMOND A. WILLIAMS.

A review is given of the development of sewers in the city of Miami. It was pointed out that the citizens of Miami were overwhelmingly in favor of extensions to the sewage collection system and construction of a treatment plant, both to be built and operated on the revenue system. The problems of rising costs and decisions regarding methods of treatment and location of treatment facilities delayed the actual construction work several years.

The Jacksonville Situation. By WILLIAM E. SHEDDON.

This city discharges raw sewage into the St. Johns River through 78 outfalls. After three river surveys, conducted by groups of cooperating organizations, involving city, state, and federal agencies, it was recommended that immediate action be taken by the city to eliminate pollution by providing adequate sewage collection and treatment facilities. A report of one of the early surveys indicated that D.O.

and B.O.D. results were acceptable for fish and wildlife, but that the diluting waters were frequently unsatisfactory for recreational use.

The Tampa Situation. By R. K. Van Camp and Paul E. Langdon.

This city, with a population increase of 40,000 people over the last 25-year period, had very little increase in sewerage facilities, with resultant pollution problems. Shellfish collection areas had been closed nearby and considerable local objections to odors and other effects were registered.

After formation of a sanitary district comprising the marginal areas and the engagement of the same firm of consulting engineers by both the city and the district, plans were developed for sewers and sewage treatment. Considerable progress was evidenced by the city, but progress by the district was slower. Nevertheless, construction was ready to start in the city areas.

New Orlando Sewage Treatment Plant. By Wylie W. Gillespie.

A description is given of the old Orlando sewage collection system, which discharged into drainage wells drilled into underground water-bearing formations. This system of disposal has been abandoned and replaced by an interceptor system and pumping stations, which deliver the sewage to a bio-filtration-trickling filter treatment plant, where it is expected that 92 per cent of the B.O.D. will be removed from a raw sewage having a B.O.D. of 350 p.p.m. The 8-m.g.d. plant was built for slightly less than $12 per capita.

The Daytona Beach Process. By Joe Williamson, Jr.

A very fine description is given of the utilization of lime water-softening sludge for chemical precipitation in an accelerated sewage treatment process known as the Daytona Beach process. Operation results, based on 9 months of intermittent operating data, indicate the removal of 60 per cent of the B.O.D. by the process. Sludge disposal is accomplished by filtration of raw sludge and disposal of the sludge cake with city garbage.

It has been found that B.O.D. removal up to 80 or 85 per cent can be accomplished if air is used, the resulting process being known as the Improved Daytona Beach process.

Advantages of the process are that the treatment plant is relatively economical to build, operation costs are comparable with other treatment processes, plants are very compact, it offers possibilities for treatment of sewage in congested areas thus saving sewer interceptor costs, and the disposal of lime water-softening sludge is accomplished simultaneously.

He concludes that for 60 to 65 per cent B.O.D. removal the plant should be built for 1-hr. detention as maximum flow rates with 0.1 cu. ft. of air per gallon of sewage; for 80 to 85 per cent B.O.D. removal the design should provide 2-hr. peak flow detention and up to 0.5 cu. ft. of air per gallon of sewage treated.

Sewage Treatment at Chattahoochee State Hospital. By Walter J. Parks, Jr.

Description is given of necessary renovations to a new activated sludge treatment plant built by inexperienced and inadequately equipped forces to place this plant in a better position to adequately treat sewage from the state hospital. The per capita cost of the original plant plus alterations amounts to $31.20.

Present Status of the National Water Pollution Control Program and Federal Aid for the Development of Sanitary Engineering Courses. By M. Allen Pond.

A review of federal legislation leading to and enabling the national water pollution program is given. The enactment of this law has given the country an over-all national policy of water pollution abatement. The program calls for the collection of data by state, federal, and local organizations and is a long-range plan designed to improve health and recreation facilities, restore land, reclaim waterways, and aid in general public welfare.

Sewage Treatment Research at the University of Florida. By G. R. Grantham.

The main objective of sewage research at the University of Florida is to reduce the costs of treatment. Studies are directed toward modifications of existing design criteria to accomplish this objective.

Ample facilities for pilot and full-scale plant research are available, as well as the necessary laboratory space.

The results of a study of sand filters with effective sand sizes ranging from 0.25 to 0.45 mm., depths from 18 to 30 in., and dosing rates from 75,000 to 175,000 g.p.a.d. may be summarized as follows:

1. Suspended solids reduction was practically constant, varying from 95 per cent for the finer sands to 89 per cent for the coarse sand. The 30-in. beds would remove only 4 to 6 per cent more suspended solids than did the 18-in. beds.
2. Deeper beds and finer sands remove more B.O.D. Effluent B.O.D. varies directly as the B.O.D. loading. Sand size is the important factor in B.O.D. removal.
3. Deeper beds and smaller sands gave greater nitrogen stabilization, bed depth being most predominant.
4. Better B.O.D. removal is obtained at higher temperatures. The 60° F. effluent B.O.D. was about twice the 80° F. B.O.D. effluent.
5. It is recommended, for single daily doses of settled sewage and environmental conditions similar to the Florida region, that dosing rates from 125,000 g.p.a.d. on sands of 0.25-mm. effective size to 150,000 g.p.a.d. on 0.30- to 0.45-mm. sands may be used with continuous operation and only weed maintenance.
6. The 18-in. depth of bed is recommended for most installations.

An operation study of standard-rate trickling filter built with different media was conducted. Little difference in degree of treatment was found in the slag, gravel, limestone, and wood slab filters and the per cent reduction in B.O.D. is not materially different at the 5- and 7-m.g.a.d. loading rates. B.O.D. reductions for these media average 60 per cent for 2-ft. filter depth, 78 per cent for the 4-ft. depth, 82 per cent for the 6-ft. depth, and 85 per cent for the 8-ft. depth. Only 70 per cent B.O.D. reduction was obtained from the 6- and 8-ft. depth wood block filters. Use of the 4-ft. filters is recommended. Suitability of material from the standpoint of deterioration was indefinite, because of the short time involved.

Another investigation involved study of the degree of treatment secured by operating standard filters at rates up to 17.5 m.g.a.d. There is no appreciable decrease in per cent reduction of B.O.D. as the hydraulic loading is increased from 5 to 15 m.g.a.d. Increased rates increase the effectiveness of a filter as a coagulating agent. Reduction of B.O.D. in 4 ft. of filter plus settling was on the order of 80 per cent, whereas there was 40 per cent more suspended solids in sewage after passing through 2 ft. of filter than before application to the filter. Effluent suspended solids are not affected by hydraulic loading and remain near 30 p.p.m.

Other research indicates that settling beyond 1 hr. is not very effective in removing B.O.D. or suspended solids. Experimental work is being conducted on sewage analysis methods and sewage chlorination. Methods of treating wood distillation wastes are being investigated.

The studies being conducted by the University of Florida should be of very practical significance to all of the southern states and should encourage similar studies in the more severe climates of the country.

Some Microbiological Aspects of Sand Filtration of Sewage. By Wilson T. Calaway.

Preliminary findings of the types of microorganisms found in sand filters are given. Indications are that filters of less than 18-in. depth might well be investigated.

Financing Sewage Works in Florida. By Townsend Wainwright.

A very interesting description of the revenue bond method of financing sewage works is given. Mr. Wainwright summarizes by saying that to bring the sale of revenue bonds to a successful conclusion, (1) a recognized bond attorney is needed to draw the proceedings and to issue the approving opinion, (2) a qualified firm of consulting engineers is needed to design and supervise construction of the project and to gather necessary basic data to the financing, and (3) a qualified financial consultant is needed to provide appropriate information which the investor will need and to arrange to get the money for the municipality under the most favorable terms possible.

K. W. Cosens

Federation of Sewage and Industrial Wastes Associations

Annual Year Book and Directory

1951

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FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS, INC.

325 Illinois Building, Champaign, Ill.

1950-51 OFFICERS

President: R. E. Fuhrman

Vice-President: Earnest Boyce

Treasurer: W. W. DeBerard

Executive Secretary-Editor: W. H. Wisely

Advisory Editor: F. W. Mohlman

PAST PRESIDENTS

Name	*Period Served*
Charles A. Emerson	1928–41
*Arthur S. Bedell	1941–42
George J. Schroepfer	1942–43
A. M. Rawn	1943–44
Albert E. Berry	1944–45
John K. Hoskins	1945–46
Francis S. Friel	1946–47
George S. Russell	1947–48
V. M. Ehlers	1948–49
A. H. Niles	1949–50

HONORS AND AWARDS

Honorary Members

The qualifications for Honorary membership in the Federation are set forth in Article II, Section 4 of the By-laws. Honorary Members are elected upon recommendation by a committee comprising the President and four latest Past Presidents, the senior Past President as chairman, in accordance with a policy adopted by the Board of Control on October 23, 1943. Honorary Members elected to date are as follows:

Charles Alvin Emerson	1941
*Arthur S. Bedell	1942
Julius W. Bugbee	1942
Langdon Pearse	1942
Charles Gilman Hyde	1943
Howard Eugene Moses	1943
Floyd William Mohlman	1944
Willem Rudolfs	1945
William John Orchard	1946
F. Wellington Gilcreas	1948
Wilford Willis DeBerard	1950

The Harrison Prescott Eddy Medal

The Harrison Prescott Eddy Medal is awarded annually to a member of any Member Association of the Federation for outstanding research contributing in important degree to the existing knowledge of the fundamental principles or processes of sewage treatment, as comprehensively described and published during any stated year in

* Deceased.

SEWAGE AND INDUSTRIAL WASTES. The award commemorates Harrison Prescott Eddy, a famous engineer and a pioneer in the art of sewage treatment.

Past recipients of the award are:

Harry Willard Gehm	1943
John Raymond Snell	1944
Lloyd R. Setter	1945
H. Heukelekian	1946
Richard Pomeroy and Fred D. Bowlus	1947
F. W. Kittrell and O. W. Kochtitzky, Jr.	1948
John W. Hood	1949
Daniel A. Okun	1950

The George Bradley Gascoigne Medal

The George Bradley Gascoigne Medal is awarded annually to a member of any Member Association of the Federation for outstanding contribution to the art of sewage treatment works operation through the successful solution of important and complicated operational problems, as comprehensively described and published during any stated year in SEWAGE AND INDUSTRIAL WASTES. This award is in memory of George Bradley Gascoigne, a prominent consultant from 1922 to 1940, who demonstrated an unusual interest in matters of sewage works operation.

Past recipients of this award are:

Kerwin L. Mick	1943
James T. Lynch and Uhl T. Mann	1944
John D. McDonald	1945
LeRoy Winfield Van Kleeck	1946
Leon S. Kraus	1947
David P. Backmeyer	1948
Wilbur N. Torpey	1949
Clarence E. Keefer	1950

The Charles Alvin Emerson Medal

The Charles Alvin Emerson Medal is awarded annually to a member of any Member Association of the Federation "for outstanding service in the sewerage and sewage treatment works field, as related particularly to the problems and activities of the Federation of Sewage and Industrial Wastes Associations in such terms as the stimulation of membership, improving standards of operational accomplishments, fostering fundamental research, etc." This award honors Charles Alvin Emerson, who served as President of the Federation from 1928 to 1941 and holds the distinction of being its first Honorary Member.

Past recipients are:

Floyd William Mohlman	1943
Willem Rudolfs	1944
Harold Warner Streeter	1945
F. Wellington Gilcreas	1946
Langdon Pearse	1947
LeRoy Winfield Van Kleeck	1948
William J. Orchard	1949
Morris M. Cohn	1950

The Industrial Wastes Medal

The Industrial Wastes Medal was established in 1949 to be awarded annually in the form of a plaque for the most outstanding contribution by an industrial employee

on any aspect of industrial wastes control, as published in SEWAGE AND INDUSTRIAL WASTES during the year preceding the award.

Past recipients are:

Roy F. Weston, Robert G. Merman and Joseph G. DeMann 1950

The Kenneth Allen Award

From 1943 through 1948, meritorious personal service to the Member Associations of the Federation was recognized by the Kenneth Allen Award. The award was retired in 1948.

Recipients of this award have been:

1943

Name	*Member Association*
Harry Thornton Calvert	I. S. P. (England)
Edward F. Eldridge	Michigan
John Kurtz Hoskins	Federal
Fred Merryfield	Pacific Northwest
Edward P. Molitor	New Jersey
Robert S. Phillips	North Carolina
Alfred Henry Weiters	Iowa
William Homer Wisely	Central States

1944

Name	*Member Association*
Albert Edward Berry	Canadian Institute
Van Porter Enloe	Georgia
Albert Legrand Genter	Maryland-Delaware
F. Wellington Gilcreas	New England
Charles A. Holmquist	New York
Dana Ewart Kepner	Rocky Mountain
Leon Benedict Reynolds	California
Wilson Waldo Towne	Dakota

1945

Name	*Member Association*
Howard Eugene Moses	Pennsylvania
George S. Russell	Missouri
Dario Travaini	Arizona
Frederick Holman Waring	Ohio
Joe Williamson, Jr.	Florida
Murray Alderson Wilson	Kansas

1946

Name	*Member Association*
E. J. M. Berg	Texas
Frank E. DeMartini	Federal
John R. Downes	New Jersey
Thomas J. Doyle	Michigan
John Henry Garner	I. S. P. (England)
Harold Benedict Gotaas	North Carolina
William P. Hughes	Pacific Northwest
Theodore R. Lovell	Iowa
George W. Martin	Central States

1947

Name	*Member Association*
William T. Knowlton	California
Floyd W. Pinney	Dakota
Gilbert R. Frith	Georgia
Clarence E. Keefer	Maryland-Delaware
Stuart E. Coburn	New England
Wellington Donaldson	New York
Henry J. Darcey	Oklahoma
Carroll H. Coberly	Rocky Mountain
William Storrie	Canadian Institute
William Merriam Cobleigh	Montana

1948

Name	*Member Association*
George W. Marx	Arizona
David Bryon Lee	Florida
William Q. Kehr	Missouri
F. Dean Stewart	Ohio
Francis deSales Friel	Pennsylvania

The Arthur Sidney Bedell Award

Established in 1948, the Arthur Sidney Bedell Award acknowledges extraordinary personal service to the Member Associations of the Federation. Each Member Association is privileged once in every three years to name one of its members to receive the award, which may be earned by organizational leadership, administrative service, membership activity, stimulation of technical functions, or similar participation. The award is named for the second President of the Federation, who exemplified its purpose by his long devotion and contribution to the affairs of the New York State Sewage Works Association.

Past recipients follow:

1949

Name	*Member Association*
Harry P. Croft	New Jersey
Victor Marcus Ehlers	Texas
R. Paul Farrell	Kentucky-Tennessee
Carl Edwin Green	Pacific Northwest
Frederick Leon McDonald	Arkansas
William Thomas Lockett	I. S. P. (England)
William McKinney Piatt	North Carolina
Walter Asa Sperry	Central States
Harold Warner Streeter	Federal
John L. Strelow	Iowa

1950

Name	*Member Association*
Leland Bradney	Dakota
John Chester Brigham	New York
Herbert B. Foote	Montana
L. L. Hedgepeth	Virginia
Theodore J. Lafreniere	Canada
Robert G. McCall	West Virginia
Edward Alexander Reinke	California
Frank S. Taylor	Oklahoma
LeRoy Winfield Van Kleeck	New England

William Hugh Weir	Georgia
Leonard Oliver Williams, Jr.	Rocky Mountain
Abel Wolman	Maryland-Delaware

The William D. Hatfield Award

The William D. Hatfield Award recognizes outstanding annual sewage works operation reports. Following the 1946 award, the Board of Control authorized identical awards for outstanding annual reports prepared (1) for plants serving less than 10,000 population, (2) for plants serving populations of 10,000 to 100,000, and (3) for plants serving populations of more than 100,000 persons.

Recipients of this award have been:

1946

Walter M. Kunsch

1947

Name	*Plant Population Classification*
F. E. Peterson	Under 10,000
John R. Szymanski	10,000 to 100,000
Warren H. Sleeger and George J. Schroepfer	Over 100,000

1948

Name	*Plant Population Classification*
F. E. Peterson (Previous Winner)	Under 10,000
Thomas T. Hay	10,000 to 100,000
Kerwin L. Mick	Over 100,000

1949

Name	*Plant Population Classification*
Russell D. Craun	Under 10,000
George W. Martin	10,000 to 100,000
Thomas T. Hay (Previous Winner)	10,000 to 100,000

1950

Name	*Plant Population Classification*
William L. Edwards	Under 10,000
Walter A. Sperry	10,000 to 100,000
John R. Szymanski (Previous Winner)	10,000 to 100,000
John W. Johnson	Over 100,000

Membership Prizes

Prizes for membership activity in its various Member Associations have been awarded by the Federation since 1943. The following Member Associations have received these prizes:

Association	*Year*
Federal Sewage Research Assn. and Central States Sewage Works Assn.	1943
Missouri Water and Sewerage Conf. and Central States Sewage Works Assn.	1944

Arizona Sewage and Water Works Assn. and Canadian Institute on Sewage and Sanitation....1945
Oklahoma Water and Sewage Conf. and Canadian Institute on Sewage and Sanitation....1946
Institute of Sewage Purification (Eng.) and Arkansas Water and Sewage Conference....1947
Pennsylvania Sewage and Industrial Wastes Association and West Virginia Sewage and Industrial Wastes Association..1948
Ohio Sewage and Industrial Wastes Treatment Conference and Alabama Water and Sewage Association....1949
Ohio Sewage and Industrial Wastes Treatment Conference and Sewage Works Section, Louisiana Conference on Water Supply and Sewerage....1950

Quarter Century Operators' Club

The Quarter Century Operators' Club is an informal group comprising Active or Corporate Members of any Member Association who had been engaged in sewage treatment works operation, on a full-time resident basis, twenty-five years prior to the date of their admission into the Club. The Club was created in 1941 under the sponsorship of Frank Woodbury Jones, who serves as its registrar. The roster:

*Charles C. Agar
*Reuben A. Anderson
Harry M. Beaumont
George C. Behnke
Julius W. Bugbee
Raymond G. Case
E. Sherman Chase
Stuart E. Coburn
Morris M. Cohn
Rodney E. Cook
Earl Devendorf
John R. Downes
*Almon L. Fales
Harry M. Freeburn
Arnold H. Goodman
William P. Gyatt
Wm. C. Hamm
George I. Hanson
William D. Hatfield
*Charles C. Hommon
Frank W. Jones
Harry J. Krum
Roy S. Lanphear
John V. Lewis
George S. Long
Winfield S. Mahlie
C. D. McGuire
*Paul Molitor, Sr.
I. H. Nevitt
Arthur H. Niles
John R. Palmer
Wm. M. Piatt
Wm. A. Ryan
Theodore C. Schaetzle
Glenn Searls
John S. Simmerman
H. W. Streeter
Myron W. Tatlock
S. L. Tolman
Henry Van Der Vliet
Edwin S. Wagner
Charles E. Wheeler, Jr.

ANNUAL MEETINGS AND CONVENTIONS

Annual Meeting Number	*Location*	*Date*
1	Chicago, Illinois†	October 16, 1928
2	New York, New York†	January 18, 1929
3	New York, New York†	January 14, 1930
4	New York, New York†	January 22, 1931
5	New York, New York†	January 22, 1932
6	New York, New York†	January 19, 1933
7	New York, New York†	January 18, 1934

* Deceased.
† Annual business meeting of Board of Control.

Annual Meeting Number	*Location*	*Date*
8	New York, New York†	January 18, 1935
9	New York, New York†	January 16, 1936
10	New York, New York†	January 22, 1937
11	New York, New York†	January 21, 1938
12	New York, New York†	January 20, 1939
13	New York, New York†	January 18, 1940
	Chicago, Illinois‡	October 3–5, 1940
14	New York, New York†	January 15, 1941
	New York, New York‡	October 9–11, 1941
15	Cleveland, Ohio§	October 22–24, 1942
16	Chicago, Illinois§	October 21–23, 1943
17	Pittsburgh, Pa.§	October 12–14, 1944
18	Chicago, Illinois†	October 17–18, 1945
19	Toronto, Ont., Can.§	October 7–9, 1946
20	Philadelphia, Pa.†	October 10, 1947
	San Francisco, Calif.‡	July 21–24, 1947
21	Detroit, Mich.§	October 18–21, 1948
22	Boston, Mass.§	October 17–20, 1949
23	Washington, D. C.§	October 9–12, 1950

DIRECTORY OF COMMITTEES

1950-51

Constitutional Committees

(*See Article VI of By-laws*)

EXECUTIVE COMMITTEE OF THE BOARD OF CONTROL

R. E. Fuhrman, *Chairman*

Earnest Boyce
F. L. Flood
L. J. Fontenelli
R. H. Gould
H. D. Lyon
A. H. Niles

PUBLICATIONS COMMITTEE

The Publications Committee arranges the technical programs for the annual conventions of the Federation and has general supervision of all publications of the Federation.

F. W. Gilcreas, *Chairman*

J. E. Cooper
Rolf Eliassen
B. M. McDill
F. W. Mohlman
W. H. Wisely

ORGANIZATION COMMITTEE

The Organization Committee examines and reports to the Board on applications for membership in the Federation and endeavors to encourage the formation of new regional associations or conferences eligible for membership.

Earnest Boyce, *Chairman*

C. R. Compton
R. H. Suttie

† Annual business meeting of Board of Control.
‡ Convention of membership-at-large.
§ Annual business meeting of Board of Control and convention of membership-at-large.

Sewage and Industrial Wastes Practice Committee

The Sewage and Industrial Wastes Practice Committee reviews and directs for publication any resolution, report, or publication which establishes professional or technical standards in the name of the Federation.

Morris M. Cohn, *Chairman*

Norval E. Anderson
D. E. Bloodgood
E. B. Cobb
G. P. Edwards
F. W. Gilcreas
K. V. Hill
C. E. Keefer
C. W. Klassen
Kerwin L. Mick
F. W. Mohlman
A. H. Niles
Langdon Pearse
Willem Rudolfs
L. W. Van Kleeck
F. M. Veatch
W. H. Wisely

Subcommittee on Use of Sludge as Fertilizer

This subcommittee of the Sewage and Industrial Wastes Practice Committee was assigned to compile a manual of practice on "Utilization of Sewage Sludge as Fertilizer." The assignment has been completed and Manual of Practice No. 2 was published under the above title in November, 1946.

A. H. Niles, *Co-Chairman*
Langdon Pearse, *Co-Chairman*

F. W. Gilcreas
F. W. Mohlman
Willem Rudolfs
T. C. Schaetzle
L. W. Van Kleeck
W. H. Wisely

Subcommittee on Occupational Hazards

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been assigned to compile a Manual of Practice on "Occupational Hazards in the Operation of Sewage Works." The manual has been completed and was distributed to the membership in December, 1944.

L. W. Van Kleeck, *Chairman*

S. H. Ash
Joseph Doman
Fred R. Ingram
L. L. Langford
L. E. West

Subcommittee on Air Diffusion

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been charged with the duty of producing a Manual of Practice on "Air Diffusion in Sewage Treatment." The final draft of the manual is under review.

Norval E. Anderson, *Chairman*

A. J. Beck
G. P. Edwards
C. T. Mickle
W. F. Schade
C. B. Townend
J. J. Wirts

Subcommittee on Sewer Maintenance

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been directed to develop a Manual of Practice on "Maintenance of Sewers and Appurtenant Structures." The first draft of the manual is in preparation.

Chairman (To be appointed)

John H. Brooks, Jr.
W. H. Brown, Jr.
G. E. Finck
Henry Fitch
Thos. B. Garry
B. H. Grout
Grant Olewiler
R. L. Patterson
Roy E. Phillips
Richard Pomeroy
Robert P. Shea
Forest Weber

Subcommittee on Chlorination of Sewage

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been assigned the development of a Manual of Practice on "The Use of Chlorine in Sewage Treatment." The manual is in a late stage of preparation.

F. W. Gilcreas, *Chairman*

N. S. Chamberlain
H. A. Faber
A. E. Griffin

Subcommittee on Standardization of Units

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been assigned to develop an approved schedule of units to be used in the reporting of plant operation and laboratory data. A committee of about forty members is at work.

Willem Rudolfs, *Chairman*

Subcommittee on Trickling Filters

This subcommittee of the Sewage and Industrial Wastes Practice Committee is engaged in the development of a Manual of Practice to be entitled "Trickling Filters—Their Characteristics and Loadings."

Kenneth V. Hill, *Chairman*

B. F. Hatch
W. S. Mahlie
Wm. E. Stanley

Subcommittee on Sewer Ordinances

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been assigned the preparation of a Manual of Practice concerning the regulation and control of the usage of public sewers. Distribution of the completed manual was begun in September, 1949.

D. E. Bloodgood, *Chairman*

H. E. Babbitt
Fred J. Biele
M. M. Cohn
Charles A. Davis
C. E. Keefer
A. F. Lehman
A. H. Niles
B. A. Poole
J. L. Quinn
C. L. Siebert

Subcommittee on Sewage Works Accounting

This subcommittee was created in 1946 for the purpose of developing a manual of practice on accounting procedures for municipal sewage works functions. Mimeographed copies of the manual in tentative form were made available for purchase in April, 1949.

F. M. Veatch, *Chairman*

G. J. Beiswanger
Charles A. Davis
Alfred A. Estrada
E. A. Farmer
K. K. Wallace
S. I. Zack

Subcommittee on Paints and Protective Coatings

This subcommittee has the function of assembling experience and data on paints and protective coatings used in sewage works, to be presented with recommendations in the form of a manual. The subcommittee was created in 1946 and is now collecting data on this subject.

Kerwin L. Mick, *Chairman*

Virgil Anderson
W. D. Hatfield
J. W. Johnson
W. T. McClenahan
F. W. Pinney
Walter A. Sperry
M. L. Robbins

Research Committee

The Research Committee has the function of stimulating research work among the various Member Associations, and of cooperating with other organizations in the promotion of research.

Willem Rudolfs, *Chairman*

D. E. Bloodgood
G. P. Edwards
H. A. Faber
H. W. Gehm
H. B. Gotaas
H. Heukelekian
R. D. Hoak
R. Manganelli
H. J. Miles
F. W. Mohlman
H. E. Orford
G. M. Ridenour
C. C. Ruchhoft
N. H. Sanborn
C. N. Sawyer
L. R. Setter
H. A. Trebler
L. W. Van Kleeck

Subcommittee on Toxicity of Industrial Wastes

This subcommittee of the Research Committee is functioning in three sections:

Section I. Critical review of literature; Willem Rudolfs, *Chairman*, C. E. Barnes, P. Doudoroff, G. P. Edwards, H. Heukelekian, F. W. Kittrell, C. E. Renn and R. F. Weston.

Section II. Development of methods for toxicity determinations on wastes; J. A. McCarthy, *Chairman*, S. E. Coburn, G. P. Edwards, H. Heukelekian, E. Hurwitz, R. S. Ingols, C. C. Ruchhoft, W. W. Sanderson, C. M. Sawyer and R. F. Weston.

Section III. Development and standardization of bio-assay methods; P. Doudoroff, *Chairman*.

Finance Committee

The Finance Committee develops the annual operating budget of the Federation and affords guidance to the Board of Control in financial affairs.

W. J. Orchard, *Chairman*

A. H. Niles
R. E. Fuhrman

Special Committees

Committee on Awards

The Committee on Awards was created by the Board of Control on October 11, 1941. Functions of the committee are to advise the Board on matters of award procedures and to make recommendations as to the annual winners of the Eddy, Gascoigne, Emerson, and Industrial Wastes medals.

H. B. Gotaas, *Chairman*

S. E. Coburn
G. A. Rohlich

Honorary Membership Committee

Authorized by the Board of Control on October 24, 1942, this committee comprises the President and four latest, living Past Presidents with the senior Past President as chairman. The committee reviews nominations for election to the grade of Honorary Member and makes recommendations to the Board on such nominations.

F. S. Friel, *Chairman*

V. M. Ehlers
R. E. Fuhrman
A. H. Niles
G. S. Russell

Operation Reports Committee

The Operation Reports Committee was created by the Board of Control on October 11, 1941, to provide for Federation recognition of outstanding operation reports. The committee now administers the annual William D. Hatfield Award.

A. F. Dappert, *Chairman*

L. E. West
G. A. Hall

Operator's Qualifications Committee

Authorized by the Board of Control on October 11, 1941, the Operator's Qualifications Committee is assigned to "establish minimal qualifications for operators of various classes of treatment works." The committee also has the duty of collecting and compiling data on present procedures in the licensing and certification of operators, for reference to Member Associations.

L. W. Van Kleeck, *Chairman*

Benjamin Benas
T. C. Schaetzle

Industrial Wastes Committee

The Industrial Wastes Committee was created by the Board of Control on October 23, 1943, for the purpose of developing interest in this important field and to direct a program whereby the Federation may be of service in industrial waste problems.

F. W. Mohlman, *Chairman*

H. E. Babbitt
R. R. Balmer
D. E. Bloodgood
H. W. Gehm
W. B. Hart
L. L. Hedgepeth
R. W. Hess
H. S. Kline
L. F. Oeming
Wm. S. Wise

Nominating Committee

The special Nominating Committee was created by the Board of Control on October 9, 1946, to function in an advisory capacity to the Election Committee. The Nominating Committee is to comprise the last five living Past Presidents, with the senior Past President as chairman.

J. K. Hoskins, *Chairman*

V. M. Ehlers
F. S. Friel
A. H. Niles
G. S. Russell

Quarter Century Operators' Club Committee

The special Quarter Century Operators' Club Committee was created by the Board of Control on October 9, 1946. It is the function of this Committee to establish eligibil-

ity requirements, process membership applications, maintain the roster and supervise the activities of the Quarter Century Operators' Club.

Frank W. Jones, *Chairman*

Stuart E. Coburn — Harold W. Streeter

Legislative Analysis Committee

The Legislative Analysis Committee was created by the Board of Control on October 17, 1945, to study legislation pertinent to the interests of the Federation and to serve the Board in advisory capacity.

David B. Lee, *Chairman*

L. D. Matter — C. I. Sterling
C. E. Schwob — R. L. Winget

Constitution and By-laws Committee

The Constitution and By-laws Committee was created by the Board of Control on October 10, 1947, to review and develop recommendations for the amendment of the Constitution and By-laws of the Federation as may be deemed advisable under changing conditions.

C. A. Emerson, *Chairman*

F. S. Friel — W. J. Orchard
F. W. Gilcreas — G. S. Russell

Committee on Emergency Planning

Created in 1948, the Committee on Emergency Planning is the medium of Federation cooperation with Federal agencies and others in matters pertaining to sanitation requirements and practices in the event of national emergency or disaster.

C. W. Klassen, *Chairman*

M. R. Golly — David B. Lee
W. A. Hardenbergh — B. A. Poole

Committee on Sewer Revenue Rates and Rate Structures

The Committee on Sewer Revenue Rates and Rate Structures was created by the Board of Control in 1948 to study and advise the Board on matters of Federation policy appertaining to sewer revenue financing procedures.

G. J. Schroepfer, *Chairman*

H. R. Green — M. W. Tatlock
W. E. Stanley — F. M. Veatch

Committee on Materials Allocation

The Committee on Materials Allocation was created by the Board of Control on October 12, 1950. The function of the Committee is to endeavor to bring about uninterrupted allocation of necessary materials to construction, maintenance and operation of wastes collection, treatment and disposal facilities in times of national emergency.

C. H. Young, *Chairman*

F. L. Flood — R. S. Rankin
W. A. Hardenbergh — A. H. Wymore

Committee on Chlorine Supply

Created on October 12, 1950, the Committee on Chlorine Supply is charged with the duty of investigating the presently unsatisfactory conditions surrounding the sale and distribution of chlorine for sanitation purposes, and to offer early recommendations for appropriate action to be taken by the Federation.

L. F. Oeming, *Chairman*

L. H. Enslow
L. L. Hedgepeth
A. H. Niles
G. A. Rhame

Joint Committees With Other Associations

Committee on Standard Methods of Sewage and Industrial Wastes Analysis

Created by the Board of Control on January 22, 1931, the Committee on Standard Methods of Sewage and Industrial Wastes Analysis has functioned with similar committees of the American Water Works Association and American Public Health Association in the production of the laboratory manual *Standard Methods for the Examination of Water and Sewage.* In 1947 the Federation became a joint publisher of this book with the above associations. The committee is presently engaged in a comprehensive research project on analytical methods, which project is being financed by grants made through the National Institutes of Health.

W. D. Hatfield, *Chairman*

L. D. Betz
D. E. Bloodgood
A. M. Buswell
S. E. Coburn
G. P. Edwards
A. J. Fisher
Keeno Fraschino
H. Heukelekian
R. D. Hoak
E. F. Hurwitz
R. S. Ingols
J. E. Kinney
F. W. Kittrell
W. S. Mahlie
M. G. Mellon
E. W. Moore
M. Starr Nichols
Richard Pomeroy
C. C. Ruchhoft
Willem Rudolfs
W. W. Sanderson
C. N. Sawyer
W. D. Sheets
G. E. Symons

R. F. Weston

Committee on Water and Sewage Works Development

The Committee on Water and Sewage Works Development was organized in 1943 to promote the planning of water and sewage works and to encourage the inclusion of such projects in postwar planning programs. The committee, temporarily inactivated, comprises representatives of the Water and Sewage Works Manufacturers Association, American Water Works Association, New England Water Works Association and the Federation of Sewage and Industrial Wastes Associations. Federation representatives are:

C. A. Emerson
G. J. Schroepfer

Special Convention Committees

Convention Management Committee

The function of this committee is to supervise details of the management of the Annual Meetings of the Federation.

W. J. Orchard, *Chairman*

Dorothy E. Dimmers
George W. Martin
H. E. Schlenz
W. H. Wisely

Meeting Place Committee

This committee reviews invitations received for the Annual Meetings of the Federation and makes recommendations to the Board of Control in regard to the time and place of such meetings.

R. E. Fuhrman, *Chairman*

Earnest Boyce
Dorothy E. Dimmers
R. F. Hayes
A. H. Niles
R. F. Orth
W. H. Wisely

Publicity and Attendance Committee

The function of this committee is to prepare publicity releases in connection with the Annual Meetings of the Federation and to direct the distribution of such material.

L. H. Enslow, *Chairman*

M. M. Cohn
W. A. Hardenbergh

SUMMARY OF MEMBERSHIP

(As at December 31, 1950)

Federation Members

Honorary Members	10
Associate Members	76
Member Associations	37
Active Members	5020
Corporate Members	108

Net Membership of Member Associations*

Member Association	Active	Honorary	Corporate	Total
Alabama	30	—	4	34
Argentina	—	—	—	—
Arizona	27	—	3	30
Arkansas	47	—	—	47
California	409	1	—	410
Canadian Inst.	349	—	—	349
Central States	526	3	16	545
Dakota	48	—	—	48
Federal	118	—	—	118
Florida	97	—	—	97
Georgia	36	—	—	36
Germany	33	—	—	33
Iowa	152	—	—	152
ISE (Eng.)	14	—	—	14
ISP (Eng.)	177	—	—	177
Kansas	42	—	1	43
Kentucky-Tennessee	108	—	5	113
Louisiana	3	—	—	3
Maryland-Delaware	56	—	—	56
Michigan	267	—	1	268
Missouri	40	—	1	41
Montana	41	—	6	47
New England	303	2	—	305
New Jersey	161	1	—	162
New York	582	1	11	594
North Carolina	93	—	—	93
Ohio	274	—	16	290
Oklahoma	35	—	—	35
Pacific Northwest	185	—	—	185
Pennsylvania	358	2	28	388
Puerto Rico	9	—	—	9
Rocky Mountain	74	—	—	74
South Carolina	15	—	—	15
Swiss	15	—	—	15
Texas	116	—	—	116
Virginia	88	—	13	101
West Virginia	92	—	3	95
Totals	5020	10	108	5138

* Not including Dual Members.

Directory of Members

MEMBER ASSOCIATIONS

Alabama Water and Sewage Association—Sewage Works Section (Affiliated 1948).

Territory: State of Alabama.
President: John A. Stalcup; *Vice-President:* E. E. Love; *Director:* R. C. Barton; *Treasurer:* G. H. Dunstan; *Acting Treasurer:* L. Hubbs; *Secretary:* Alex O. Taylor, Box 69, Auburn, Ala.

Argentina Society of Engineers, Sanitary Engineering Division (Affiliated 1936).

Territory: Republic of Argentina.
FSIWA Contact Member: E. B. Besselievre, The Dorr Co., Barry Place, Stamford, Conn.

Arizona Sewage and Water Works Association—Sewage Works Section (Affiliated 1928).

Territory: State of Arizona.
President: George W. Marx; *First Vice-President:* Stuart P. Henderson; *Second Vice-President:* M. P. Goudy; *Director:* Harold Yost; *Secretary-Treasurer:* Mrs. Helen Rotthaus, c/o Sanitary Engineering Div., State Dept. of Health, Capitol Bldg., Phoenix, Ariz.

Arkansas Water and Sewage Conference—Sewage Works Section (Affiliated 1946).

Territory: State of Arkansas.
Chairman: Elmo A. Lambert; *Vice-Chairman:* Cecil A. Brown; *Director:* B. W. Dees; *Secretary-Treasurer:* Harrison Hale, University of Arkansas, 118 Chemistry Bldg., Fayetteville, Ark.

California Sewage Works Association (Affiliated 1928).

Territory: State of California.
President: F. G. Nelson; *First Vice-President:* H. B. Gotaas; *Second Vice-President:* A. G. Pickett; *Director:* K. A. Kiern; *Secretary-Treasurer:* Lawrence H. Cook, Box 696, Menlo Park, Calif.

Canadian Institute on Sewage and Sanitation (Affiliated 1933).

Territory: Dominion of Canada.
President: D. A. R. McCannel; *Vice-President:* C. S. Anderson; *Director:* William Storrie; *Secretary-Treasurer:* A. E. Berry, Ontario Dept. of Health, Parliament Buildings, Toronto, Ont., Can.

Central States Sewage Works Association (Affiliated 1928).

Territory: States of Illinois, Indiana, Wisconsin, and Minnesota.
President: H. T. Rudgal; *First Vice-President:* M. L. Robins; *Second Vice-President:* W. W. Mathews; *Third Vice-President:* E. Hurwitz; *Director:* George Martin; *Secretary-Treasurer:* A. Paul Troemper, Div. of Sanitary Engineering, Illinois Dept. of Public Health, Springfield, Ill.

Dakota Water and Sewage Works Conference—Sewage Works Sections (Affiliated 1936).

North Dakota Section

Territory: State of North Dakota.
President: H. H. Behlmer; *Vice-President:* K. R. Johnson; *Director:* John Kleven; *Secretary-Treasurer:* Jerome H. Svore, c/o State Dept. of Health, Bismarck, N. Dak.

South Dakota Section

Territory: State of South Dakota.
President: Plummer Wells; *Vice-President:* Wallace Johnson; *Director:* John Kleven; *Secretary-Treasurer:* Charles E. Carl, c/o State Board of Health, Div. of Sanitary Engineering, Pierre, S. Dak.

Federal Sewage Research Association (Affiliated 1930).

Territory: Federal employees wherever stationed.
President: William H. Cary, Jr.; *Vice-President:* Gordon E. McCallum; *Director:* Robert N. Clark; *Secretary-Treasurer:* Leonard B. Dworsky, c/o Div. of Water Pollution Control, U.S.P.H.S., Washington 25, D.C.

Florida Sewage and Industrial Wastes Association (Affiliated 1941).

Territory: State of Florida.
President: Walter J. Parks, Jr.; *Vice-President:* John E. Kiker, Jr.; *Director:* J. R. Hoy; *Secretary-Treasurer:* Perry M. Teeple, Florida State Board of Health, P. O. Box 210, Jacksonville, Fla.

Georgia Water and Sewage Association—Sewage Works Section (Affiliated 1936).

Territory: State of Georgia.
President: V. P. Enloe; *First Vice-President:* V. D. Parrott, Jr.; *Second Vice-President:* L. C. Bowen; *Director:* R. S. Ingols; *Secretary-Treasurer:* A. T. Storey, 1210 Hemphill Ave., N. W., Atlanta, Ga.

German Sewage Technologists Association (Affiliated 1950).

Territory: Germany.
President: Max Prüss; *Vice-President:* Franz Schrier; *Director:* Karl Imhoff; *Secretary-Treasurer:* Wilhelm Bucksteeg, Schliessfach 1112, Ruhrverband, Essen, Germany.

Institute of Sewage Purification—England (Affiliated 1932).

Territory: British Empire.
President: C. B. Townend; *Director:* Martin Lovett; *Treasurer:* H. Booth; *FSIWA Contact Member:* Martin Lovett, 206 Bradford, Wakefield, Yorkshire, England.

Institution of Sanitary Engineers—England (Affiliated 1932).

Territory: British Empire.
President: N. Campbell-Little; *Director:* C. B. Townend; *Secretary:* Earnest V. Balsom, 118 Victoria St., Westminster, S. W. 1, London, England.

Iowa Sewage Works Association (Affiliated 1928).

Territory: State of Iowa.
President: M. F. Neuzil; *Vice-President:* M. L. Wickersham; *Director:* P. J. Houser; *Secretary-Treasurer:* Leo Holtcamp, E. Ohio St., Webster City, Ia.

Kansas Sewage Works Association (Affiliated 1935).

Territory: State of Kansas.
Chairman: D. B. Kissinger; *Vice-Chairman:* Roy Binder; *Director:* E. F. Miltner; *Secretary-Treasurer:* D. F. Metzler, c/o State Board of Health, Marvin Hall, University of Kansas, Lawrence, Kans.

Kentucky-Tennessee Industrial Wastes and Sewage Works Association (Affiliated 1946).

Territory: States of Kentucky and Tennessee.
Chairman: G. R. Watkins; *Vice-Chairman:* W. J. Eldridge; *Director:* Maurice L. Miller; *Secretary-Treasurer:* R. P. Farrell, 420 Sixth Ave., N., Nashville, Tenn.

Louisiana Conference on Water Supply and Sewerage—Sewage Works Section (Affiliated 1949).

Territory: State of Louisiana.
Chairman: H. W. Blakeman; *Vice-Chairman:* L. J. Dore; *Director:* S. S. Crawford; *Secretary-Treasurer:* S. V. Hazlip, Water and Sewerage Dept., Houma, La.

Maryland-Delaware Water and Sewerage Association—Sewage Works Section (Affiliated 1928).

Territory: States of Maryland and Delaware.
President: R. E. Fuhrman; *First Vice-President:* L. E. McClung; *Second Vice-President:* V. W. Faivre; *Director:* C. E. Keefer; *Secretary-Treasurer:* W. M. Bingley, 2411 N. Charles St., Baltimore 18, Md.

Michigan Sewage and Industrial Wastes Association (Affiliated 1930).

Territory: State of Michigan.
President: H. Delano; *Vice-President:* R. Grinnell; *Director:* L. F. Oeming; *Secretary-Treasurer:* Donald M. Pierce, Michigan Dept. of Health, Room 334, Administration Bldg., Lansing 4, Mich.

Missouri Water and Sewerage Conference—Sewage Works Section (Affiliated 1929).

Territory: State of Missouri.
Chairman: F. L. Thierfelder; *Vice-Chairman:* R. F. Bishop; *Director:* A. H. Wymore; *Secretary-Treasurer:* Warren A. Kramer, c/o State Office Bldg., Sixth Fl., Jefferson City, Mo.

Montana Sewage Works Association (Affiliated 1944).

Territory: State of Montana.
Chairman: Kurt Wiel; *Vice-Chairman:* Rodney Preator; *Director:* Earl Eby; *Secretary-Treasurer:* H. B. Foote, Div. of Sanitary Engineering, State Board of Health, Helena, Mont.

New England Sewage Works Association (Affiliated 1929).

Territory: States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island.
President: William S. Wise; *First Vice-President:* E. Sherman Chase; *Second Vice-President:* Eugene L. Bond; *Director:* F. L. Flood; *Secretary-Treasurer:* Walter E. Merrill, c/o State Dept. of Health, 511-A State House, Boston, Mass.

New Jersey Sewage and Industrial Wastes Association (Affiliated 1942).

Territory: State of New Jersey.
President: John Struss; *First Vice-President.* Sol Seid; *Second Vice-President:* Paul Molitor, Jr.; *Director:* L. J. Fontenelli; *Secretary-Treasurer:* Michael S. Kachorsky, P. O. Box 766, Manville, N. J.

New York Sewage and Industrial Wastes Association (Affiliated 1930).

Territory: State of New York.
President: John W. Johnson; *Vice-President:* J. M. MacCrea; *Director:* G. E. Symons; *Treasurer:* J. C. Brigham; *Secretary:* Ralph C. Sweeney, c/o State Dept. of Health, 21 N. Broadway, White Plains, N. Y.

North Carolina Sewage and Industrial Waste Association (Affiliated 1929).

Territory: State of North Carolina.
Chairman: W. W. Adkins; *Vice-Chairman:* H. F. Davis; *Director:* R. S. Phillips; *Secretary-Treasurer:* E. C. Hubbard, North Carolina State Board of Health, Raleigh, N. C.

Ohio Sewage and Industrial Wastes Treatment Conference (Affiliated 1932).

Territory: State of Ohio.
Chairman: H. S. Kline; *First Vice-Chairman:* Walter E. Gerdel; *Second Vice-Chairman:* Donald G. Stevens; *Director:* B. M. McDill; *Secretary-Treasurer:* John E. Richards, 301 Ohio Depts. Bldg., Columbus 15, Ohio.

Oklahoma Water, Sewage and Industrial Waste Conference—Sewage Works Section (Affiliated 1929).

Territory: State of Oklahoma.
President: R. B. Riddle; *Vice-President:* F. S. Lytle; *Director:* J. T. Sprague; *Secretary-Treasurer:* H. J. Darcey, State Dept. of Health, Oklahoma City 5, Okla.

Pacific Northwest Sewage Works Association (Affiliated 1933).

Territory: States of Washington, Oregon, and Idaho.
President: W. P. McNamara; *First Vice-President:* W. W. Tinniswood; *Second Vice-President:* C. M. Everts, Jr.; *Director:* W. P. Hughes; *Secretary-Treasurer:* Robert E. Leaver, Dept. of Health, 1523 Smith Tower, Seattle 4, Wash.

Pennsylvania Sewage and Industrial Wastes Association (Affiliated 1928).

Territory: State of Pennsylvania.
President: H. T. Reuning; *First Vice-President:* R. M. Bolenius; *Second Vice-President:* R. F. Weston; *Director:* C. H. Young; *Secretary-Treasurer:* Bernard S. Bush, c/o Pennsylvania Dept. of Health, Kirby Health Center, Wilkes-Barre, Pa.

Puerto Rico Water and Sewage Works Association (Affiliated 1947).

Territory: Puerto Rico.
President: Manuel Vinas Sarba; *Vice-President:* Wm. C. Hill; *Director:* Felipe Bosch; *Secretary-Treasurer:* Alvah R. Pierce, c/o Puerto Rico Aqueduct & Sewer Service, Box 2832, San Juan 12, P. R.

Rocky Mountain Sewage Works Association (Affiliated 1947).

Territory: States of Wyoming, Colorado, and New Mexico.
President: S. Gass; *Vice-President:* R. Sherard; *Director:* L. O. Williams; *Secretary-Treasurer:* C. H. Coberly, Room 329, 1441 Welton Street, Denver 2, Colo.

South Carolina Water and Sewage Works Association—Sewage Works Section (Affiliated 1949).

Territory: State of South Carolina.
President: George A. Rhame; *Vice-President:* E. D. Fry; *Director:* George A. Rhame; *Secretary-Treasurer:* W. T. Linton, Wade Hampton Bldg., Columbia, S. C.

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CONSTITUTION AND BY-LAWS OF THE FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

Adopted January 15, 1941. As amended to October 8, 1950.

CONSTITUTION

ARTICLE I

NAME

The name of this organization shall be the Federation of Sewage and Industrial Wastes Associations, hereinafter designated as the Federation.

ARTICLE II

OBJECTIVES

The objectives of this Federation shall be: The advancement of fundamental and practical knowledge concerning the nature, collection, treatment and disposal of sewage and industrial wastes; the design, construction, operation and management of sewer systems and treatment works; the study, promotion and encouragement of improved sanitation of waterways; the correlation and strengthening of regional and state sewage and industrial wastes associations or conferences within or without the United States of America; the publication of a journal; and other relevant activities.

ARTICLE III

MEMBERSHIP

The membership of the Federation shall consist of regional or state associations or conferences, either within or without the territory of the United States of America, hereinafter designated as Member Associations, whose objectives and constitutions are in harmony with the purposes of this Federation, and of individuals or corporations as specified in the By-Laws, subject to the conditions and limitations prescribed in the Constitution and By-Laws of the Federation.

ARTICLE IV

ORGANIZATION

SECTION 1. The affairs of the Federation shall be conducted by a Board of Control (hereinafter designated as the Board) under such rules as the Board may determine, subject to the specific conditions of this Constitution and By-Laws.

SECTION 2. The officers of the Federation shall be a President, a Vice-President, a Secretary, and a Treasurer.

SECTION 3. The Board shall consist of:

(a) The President of the Federation.
(b) The Vice-President of the Federation.
(c) The Treasurer of the Federation.
(d) One Director to be appointed by and to represent each Member Association.
(e) Six Directors-at-Large, of whom three are to be elected by the Executive Committee of the Sewage Works Division of the Water and Sewage Works Manufacturers Association, and three by the Directors representing the Member Associations.
(f) The latest living Past President of the Federation.
(g) The Chairman of the Organization Committee.
(h) The Chairman of the Publications Committee.
(i) The Chairman of the Sewage and Industrial Wastes Practice Committee.
(j) The Chairman of the Research Committee.
(k) The Chairman of the Finance Committee.

SECTION 4. The terms of office of the President, Vice-President, and Treasurer shall be one year, and the Directors three years, which terms shall start at the beginning of the last session of the Annual Meeting of the Board at which they are elected and continue until a successor qualifies. The Secretary shall be appointed by the Board for the term of office stated in the By-Laws. In the case of a vacancy in the office of President, the Vice-President shall act in his place for the unexpired term. In case the Vice-President cannot act, the latest living Past President shall do so. In the case of a vacancy in the office of Treasurer or of any Director-at-Large, the Executive Committee shall appoint an Active Member to fill such office for the unexpired term.

SECTION 5. The President shall be ineligible for re-election. The Vice-President and Directors shall not be eligible for reappointment or for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

SECTION 6. The President of the Federation shall be the Presiding Officer of the Board.

SECTION 7. A quorum of the Board shall consist of a majority of its members. Absent members may vote by proxy, all such proxies being counted in determining a quorum.

ARTICLE V

NOMINATION AND ELECTION OF OFFICERS AND DIRECTORS

SECTION 1. The Annual Meeting of the Board shall be held in October during the Annual Convention of the Federation on such day or days as may be decided by the Board. In event the Annual Convention does not occur in October the annual meeting of the Board shall be held in the office of the Federation on the third Saturday in October. Other meetings of the Board may be held as is provided in the By-Laws.

At the Annual Meeting the Directors representing the Member Associations shall meet under the chairmanship of the President of the Federation, and shall by a majority vote of all such Directors, elect a President, Vice-President, Treasurer and one Director-at-Large. Absent Directors may vote by proxy. Any candidate so elected shall be an Active Member of some Member Association and shall signify willingness to serve. Any candidate elected as President or Vice-President shall at some time previous to such election have been a member of the Board of Control.

SECTION 2. One Director on the Board of Control to represent each Member Association shall be elected by each Member Association. Each Director so elected shall be an Active Member of the respective Member Association and in good standing at the time of his election.

In the case of any Director, representing a Member Association, retiring for any cause before his term is completed, the governing board of the Member Association shall designate his successor, who shall serve for the unexpired portion of his term.

ARTICLE VI

Except as specifically mentioned herein, this Constitution shall take effect immediately upon its adoption by the Board of Control.

ARTICLE VII

AMENDMENTS

Amendments to this Constitution may be made by a two-thirds vote of the total membership of the Board, notice of the proposed amendment having been given to each member of the Board and to the Secretary of each Member Association not less than sixty days in advance of the meeting, at which the said amendments are to be voted upon.

BY-LAWS

ARTICLE I

MEMBER ASSOCIATIONS

SECTION 1. Any regional or state association or conference, or other organization whose objectives and constitution are in harmony with those of the Federation, may be granted membership in the Federation by a majority vote of the Board; provided, that the constitution of the applicant association or conference has been examined and certified by the Board as being in accord with Article III of the Constitution of this Federation; and provided further, that certification shall be made by the association seeking admission to membership that the Constitution and By-Laws of the Federation are accepted by it.

SECTION 2. Any Member Association may withdraw from the Federation at the end of any fiscal year by giving three months' notice of such intention, provided that the dues of such Member Association in the Federation are fully paid up to time of withdrawal.

SECTION 3. Any Member Association may be excluded from this Federation, at the pleasure of the Board, for non-payment of dues, as hereinafter provided, or for any change in its constitution that may bring it into conflict with the Constitution or By-Laws of the Federation.

SECTION 4. Any change in the existing constitution or by-laws of a Member Association shall be reported in full to the Secretary of the Federation within thirty days after its adoption by said Member Association.

ARTICLE II

CLASSIFICATION OF MEMBERS

SECTION 1. Membership of the Federation shall be composed of Member Associations, Honorary Members, Associate Members and Sustaining Members. Membership in the Member Associations shall consist of Active Members and Corporate Members only.

SECTION 2. An Active Member shall be a superintendent, manager, operator, or employee of a sewage or industrial wastes system or treatment works; a professional engineer; a chemist, bacteriologist, biologist, or any qualified person professionally engaged or interested in the advancement of knowledge relating to the disposal or treatment of sewage and industrial wastes or improved sanitation of waterways.

SECTION 3. A Corporate Member shall be a Sewerage Board, Department or Commission; Sanitary District; Department of Public Works handling sewerage; Industrial Corporation; National, State, District or Municipal Board or Department of Health; or other body, corporation or organization engaged or interested in at least one of the stated objectives of the Federation, and shall be entitled to one representative whose name shall appear on the roll of members and who shall have all the rights and privileges of an Active Member. This representative may be changed at the convenience and pleasure of the Corporate Member on written notice to the Secretary of the Member Association to which the Corporate Member is accredited.

SECTION 4. An Honorary Member shall be a person of acknowledged eminence in one or more fields of activity within the scope of the stated objectives of the Federation. Candidates may be nominated by any Member Association but can be elected only by a majority vote of the Board. There shall not be more than ten living Honorary Members at any time. Honorary Members shall be elected for life and shall receive, without cost, all the publications of the Federation that are distributed to its members.

SECTION 5. An Associate Member shall be a person, firm, or corporation engaged in the manufacturing or furnishing of supplies, materials, or equipment for the construction, operation or maintenance of sewage or industrial waste facilities, and shall be elected by affirmative vote of a majority of the Board after consideration of written application duly made to the Secretary.

SECTION 6. A Sustaining Member shall be an individual or a corporation interested in the general objectives of the Federation.

ARTICLE III

DUES

SECTION 1. The status and dues of the different classes of members established by Member Associations, as applied to their members, shall be as determined by the Member Association.

SECTION 2. (a) For each Active Member the annual dues shall be Five Dollars, payable in advance by the Member Associations to the Secretary of the Federation.

(b) For each Corporate Member the annual dues shall be Ten Dollars, payable to the Secretary of the Federation by February 1 of each year.

(c) For each Sustaining Member the annual dues shall be not less than Twenty-five Dollars, payable to the Secretary of the Federation by February 1 of each year.

(d) For each Associate Member the annual dues shall be Twenty Dollars, payable to the Secretary of the Federation by February 1 of each year.

(e) Corporate Members, Sustaining Members, or Associate Members whose dues remain unpaid on March 1 of any year may be dropped from membership on action of the Executive Committee.

(f) The dues for Member Associations outside the United States of America and its territorial possessions shall be greater than the

the amounts hereinbefore specified by an amount to be fixed annually by the Board as equivalent to the added cost for mailing the Journal to such associations as compared with the average cost for mailing to members residing within these limits.

(g) Active Members, paying full dues, and Corporate Members of Member Associations, and Associate and Sustaining Members of the Federation, in good standing, shall be entitled to one copy each of all publications that are distributed by the Federation to its members.

SECTION 3. The fiscal year of the Federation shall begin on January 1, and annual dues shall be collectible on that date and shall have been paid before February 1. If the dues of any Member Association shall not have been paid by February 1, fifteen days' notice of the dues in arrears shall be given to that association, after which time, if the dues remain unpaid, that association may be dropped from the rolls of the Federation on action by the Board, as provided in Article I, Section 3, of these By-Laws.

SECTION 4. Any member, newly elected before June 30, shall pay full dues and shall be entitled to all the publications of the Federation that are distributed to its members during the year. Members elected after June 30 shall pay one-half the regular dues for that year, and shall be entitled to all of the publications distributed during the half year beginning July 1.

SECTION 5. In transmitting dues to the Federation, each Member Association shall forward with them a list of the names, professional titles and correct mailing addresses of all members of all classes of the said Association who are in good standing and are entitled to receive the Journal or other distributed publications of the Federation during the ensuing year.

ARTICLE IV

DUTIES OF OFFICERS AND DIRECTORS

SECTION 1. The President shall have general supervision of the affairs of the Federation, and shall preside at all conventions of the Federation and meetings of the Board. In his absence, he shall designate a Presiding Officer to act in his stead at such conventions or meetings. The President shall be, ex-officio, a member of all committees.

SECTION 2. The Vice-President shall assist the President in the performance of his duties, and act in his stead when required.

SECTION 3. The Board of Control shall be the legal representative of the Federation, and as such shall manage its affairs subject to the conditions and limitations prescribed in the Constitution and By-Laws; direct the investment and care of funds of the Federation; make appropriations for specific purposes; appoint employees and fix their compensation; take measures to advance the interests of the Federation; and generally direct its business. The Board shall not incur indebtedness beyond the funds in the hands of the Treasurer and the Secretary. The Board shall hold a meeting during the Annual Convention. Other meetings shall be held at the call of the President, or on petition addressed to the Secretary and signed by ten or more members of the Board representing not less than seven Member Associations. Notice of all meetings shall be issued by the Secretary at least fifteen days in advance of such meetings to all members of the Board and to the Secretary of each Member Association.

At the Annual Meeting the Board shall appoint a Secretary to serve for a term of two years, unless removed for cause by the Board.

Except as otherwise provided in the Constitution and By-Laws, all questions before the Board shall be decided by a majority vote.

SECTION 4. The Treasurer shall have charge of the funds of the Federation and custody of its investments, if any. He shall pay bills against the Federation when certified by himself and the Secretary. He shall make a report for each calendar year at the Annual Meeting of the Board, showing receipts from the Secretary and other sources, the expenditures, the investments and other assets, and the liabilities of the Federation. He shall make such other reports as may be required by the Board.

He shall be bonded at the expense of the Federation, and to an amount to be determined by the Board.

He shall perform such other duties as may be assigned to him by the Board.

SECTION 5. The Secretary shall be an Active Member and, under the direction of the President and the Board of Control, shall be the executive officer of the Federation. It shall be his duty to attend all conventions and meetings of the Board, prepare the business and duly record the proceedings thereof. He shall see that all monies due the Federation are carefully collected and without loss transferred to the custody of the Treasurer. He shall scrutinize all expenditures, shall certify to the accuracy of all bills and vouchers on which money is to be paid, and shall countersign checks drawn by the Treasurer against the funds of the Federation when such drafts are known by him to be proper and duly authorized by the Board. Once every three months he shall forward to each member of the Board a financial summary of receipts and disbursements, and at the Annual Meeting of the Board shall present a balance sheet of his books as of the 31st of December and as of the 30th of September preceding the meeting, together with a report of the activities of his office.

He shall have charge of the books and records of the Federation, including lists of members of the Federation and subscribers to the Journal. He shall have charge of the mechanical production and distribution of the Journal and other publications of the Federation, and shall handle all financial matters connected therewith.

He shall be bonded at the expense of the Federation, and to an amount to be determined by the Board.

The books of the Federation shall be audited annually at the expense of the Federation by public accountants to be appointed by the Board.

In the event that the Secretary or Treasurer shall be unable to sign checks against the funds of the Federation, the President or Vice-President shall be authorized to countersign such drafts in his stead.

SECTION 6. The Secretary shall serve as Editor of all publications of the Federation and shall receive all manuscript copy and prepare it for publication. He shall have the authority to return to the author for correction, or to reject entirely, any manuscript which may be in bad condition, illegible, or clearly deficient in respect to composition, subject matter or supporting data, or otherwise conspicuously deficient or unfit for publication. He also shall have the authority to reject any manuscript which is designed to promote commercial interests. He shall be a member of the Publications Committee and of the Committee on Sewage and Industrial Wastes Practice. Decisions of the Editor relative to rejection of manuscripts shall be subject to appeal to the Publications Committee.

ARTICLE V

CONVENTIONS OF THE FEDERATION

The Annual Convention of the Federation shall be held at a time and place to be selected by the Board, preferably in the month of October. All conventions and meetings shall be conducted according to "Roberts Rules of Order."

Each member and guest present at any of the conventions of the Federation shall pay a registration fee of such amount as may be determined by the Executive Committee.

ARTICLE VI

COMMITTEES

SECTION 1. There shall be an Executive Committee of seven members consisting of the President, Vice-President, immediate Past President and four Directors. This committee shall be chosen by the Board at its Annual Meeting. The President of the Federation shall be Chairman, and the Secretary of the Federation shall act as Secretary of the committee. In the absence of the President, the Vice-President shall preside. The duties of this committee shall be to direct the administrative work of the Federation and carry out the policies of the Board between meetings of the latter. A quorum of the committee shall be four members.

SECTION 2. A Publications Committee shall be appointed by the Board at its Annual Meeting. It shall consist of the Secretary and at least four additional Members-at-Large. Its Chairman shall be, ex-officio, a member of the Board. The Publications Committee shall arrange the technical programs for the Annual Convention of the Federation and shall have general supervision of the Publications of the Federation and of the performance of contracts and expenditures connected therewith. The committee shall prepare general rules which, after approval by the Board, shall control the preparation, presentation, acceptance and publication of papers and shall have general supervision of such other matters of similar nature as the best interests of the Federation may require.

SECTION 3. An Organization Committee of at least three Members-at-Large shall be appointed by the Board at the Annual Meeting, and its Chairman shall be, ex-officio, a member of the Board. The Organization Committee shall examine and report to the Board on application for membership in the Federation and also shall serve in the encouragement of the formation of new regional or state associations or conferences eligible for membership, as well as serving in an advisory capacity in other matters of a similar nature as the best interest of the Federation may require.

SECTION 4. A Sewage and Industrial Wastes Practice Committee consisting of the Editor and at least four Members-at-Large shall be appointed by the Board at the Annual Meeting, and its Chairman shall be, ex-officio, a member of the Board.

Any resolution, report or publication which undertakes to establish in the name of the Federation, professional or technical standards shall be submitted to this committee, and it shall direct such matters on behalf of the Federation.

It shall give notice by publication to the membership of all such proposed standards and report its approval or disapproval of such to the Board.

It shall appoint such subcommittees as it may deem necessary properly to carry on its work.

SECTION 5. There shall be a Research Committee of at least five Members-at-Large. The Chairman shall be appointed by the Board, and the other members of the Committee may be appointed by the Chairman, by and with the consent of the President of the Federation. The Chairman shall be, ex-officio, a member of the Board.

The Research Committee shall be charged with the duty of stimulating and coordinating research work among the various Member Associations, and of cooperating with other organizations in the promotion of research work.

SECTION 6. There shall be a Finance Committee of three members consisting of the President, the latest living Past President and a Chairman to be appointed by the Board at its Annual Meeting. The committee shall present at the Annual Meeting of the Board a budget of estimated expenses of the Federation, including publications, for the ensuing year. On the adoption of the budget by a majority vote of the Board, expenses of the Federation shall be limited, as far as may be practicable, within the amounts prescribed in said budget.

The committee shall also function in general advisory capacity to the Board and to the Executive Committee in all matters relating to finances of the Federation.

SECTION 7. The Board shall appoint such other committees as may be necessary to carry on the work of the Federation.

SECTION 8. The reports and recommendations of all committees of the Federation shall be subject to approval by the Board.

SECTION 9. Members-at-Large are Active Members who are not members of the Board.

ARTICLE VII

PUBLICATIONS

All publications of the Federation shall be issued under the direction of the Board and shall be copyrighted as far as is practicable and proper.

ARTICLE VIII

AMENDMENTS

The Board of Control may amend these By-Laws in any manner not inconsistent with the Constitution by the two-thirds vote of those voting at any meeting of the Board or by sealed letter ballot, providing that a copy of such proposed amendment has been mailed by the Secretary to each member of the Board and to the Secretary of each Member Association at least thirty days prior to such meeting or letter ballot.

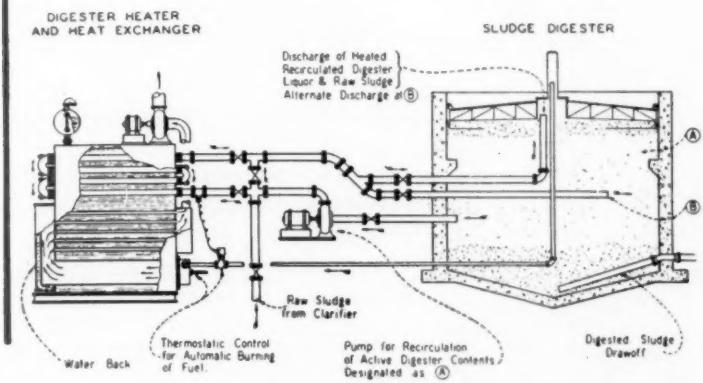
THIS METHOD OF ACCELERATING DIGESTION MAKES SENSE !

Four No. 500 P.F.T. Digester Heaters and Heat Exchangers serve 4 85' and 6 50' P.F.T. Floating Cover Digesters at Dayton, Ohio. L. C. Hoffman, Engineer.

It has been found that action of the methane producing bacteria is less deterred by temperatures above or below the optimum than by fluctuations in temperature. P.F.T. Digester Heater and Heat Exchanger units provide a safe, practical and economical means of maintaining sewage sludge undergoing digestion at an optimum temperature.

Furthermore, there are no coils of piping in the digestion tank to become caked with sludge and therefore insulated against proper heat transfer. Circulation is such that a more uniform temperature is maintained throughout the sludge mass.

P.F.T. Digester Heaters employ methane gas from the digestion tank for fuel. P.F.T. Gas Engine Heat Exchangers employ heat from sludge gas engine jacket cooling water to keep the sludge at optimum temperature. A list of installations to date is available on request to Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.


DIGESTER HEATER AND HEAT EXCHANGER
SLUDGE DIGESTER
Discharge of Heated Recirculated Digester Liquor & Raw Sludge Alternate Discharge at (B)
(A)
(B)
Raw Sludge from Clarifier
Water Back
Thermostatic Control for Automatic Burning of Fuel.
Pump for Recirculation of Active Digester Contents Designated as (A)
Digested Sludge Drawoff

OTHER P.F.T. EQUIPMENT INCLUDES:
Floating Covers, Gas Safety Equipment, Rotary Distributors, Sprinkling Filter Nozzles, Siphons, Pre-Aerators and Gages.

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SEWAGE TREATMENT EQUIPMENT EXCLUSIVELY SINCE 1893
4241 RAVENSWOOD AVENUE CHICAGO 13, ILLINOIS
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Proceedings of Member Associations

SOUTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE

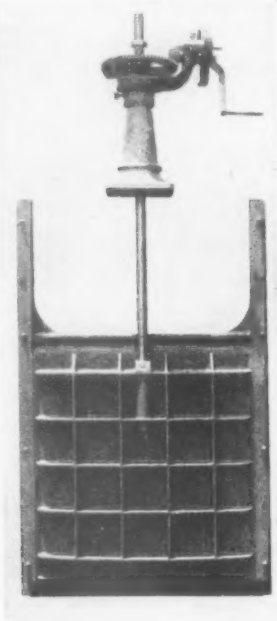
The water and sewage works operators of South Dakota opened their 16th Annual Conference in Aberdeen, S. Dak., on September 27, 1950, with a smoker and Dutch lunch through the courtesy of the host city. Following the pre-conference fun, the more serious part of the program got underway on Thursday morning, September 28, with 114 persons attending. In his welcoming address, Mayor R. S. Wallace recalled that the South Dakota Conference was started in Aberdeen in 1935. This was followed by a panel discussion on "Public Relations Between City Officials and Their Water and Sewage Works Operators." Those participating in the panel included J. E. Barger, treasurer, League of South Dakota Municipalities; Mayor R. S. Wallace, Aberdeen; Mayor J. R. Fiksdal, Webster; Charles R. Price, sewage works superintendent, Rapid City; and the panel chairman, Charles E. Carl, director, Division of Sanitary Engineering, State Dept. of Health.

An interesting paper on the "Construction of Oahe Dam" was presented by Lt. Col. A. D. Starbird, area engineer, Pierre, S. Dak., who explained the function of the new dam in the Missouri River control plan.

The afternoon session was separated into two sections. Papers presented at the water section included:

"Versenate Titration for Water Hardness," by Clarence C. Crumley,

(*Continued on page 106a*)



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SEWAGE TREATMENT PLANTS

All types of cast iron gates manufactured in either square or circular openings in sizes up to and including 72 inches.

ALL SNOW GATES and Lifts are "Parkerized" for protection against rust and corrosion.

Over 40 years continuous service to the industry.

We will be pleased to quote on any type of water controlling equipment.

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2437 East 24th Street Los Angeles 54, Calif.

Troy's Rensselaer Polytechnic Institute as it looked 100 years ago

Troy, New York, has a cast iron water main in service that was installed more than a century ago, not long after the founding of Rensselaer Polytechnic Institute, one of America's oldest schools of science. An engineer of that day, who could foresee the transition from horse-drawn vehicles to buses and ten-ton trucks, would have been bold indeed to predict a useful life of 100 years for a cast iron underground main. Yet that is the record of cast iron pipe in numerous cities in spite of the changes in a century, and the stresses imposed by modern conditions of traffic and congested underground services.

United States Pipe and Foundry Co.,
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cast iron
PIPE
FOR WATER, GAS, SEWERAGE AND INDUSTRIAL SERVICE

NUMBER THREE OF A SERIES

chief, Water Sanitation Section, South Dakota Division of Sanitary Engineering.

"Construction of New Water Plant at Huron," by Wally Johnson, water works superintendent, and E. H. Dunmire, consulting engineer, Huron.

"Fluoridation for Public Water Supplies," by Charles E. Carl, director, Division of Sanitary Engineering.

"Operation of Upflow-Sludge Blanket Type Water Treatment Plant." by H. A. Fowler, water superintendent, Vermillion.

"Water Shortage in Sioux Falls During 1950," by A. T. Hanson, chief engineer, water plant, Sioux Falls.

The sewage works section heard the following papers:

"Filter Protection During Winter Operation," by Leland Bradney, superintendent, Sioux Falls.

"The New Sewage Treatment Plant at Aberdeen," by Siger Bies, superintendent, Aberdeen.

"Present Status of Missouri River Basin Pollution Control Program," by Glen J. Hopkins, officer-in-charge, Division of Water Pollution Control, Missouri Drainage Basin, Kansas City, Mo.

"Mobile Water Pollution Control Laboratory of the Division of Sanitary Engineering," by D. C. Kalda, sanitary engineer, Division of Sanitary Engineering.

Following the discussion, those in attendance visited the mobile laboratory, which was parked outside the hotel.

Preceding the Annual Banquet, which was held on the evening of September 28, delegates enjoyed a social hour sponsored by representatives of Water and Sewage Works Manufacturers Association members. Entertainment at the banquet was sponsored by the host city of Aberdeen.

The second general session, held the morning of September 29, heard the following papers:

(*Continued on page 108a*)

PROOF
OF
"STERELATOR EFFICIENCY"

NO JOB TOO LARGE

SEND US COPY OF SPECIFICATIONS

Actual Users—THE BEST PROOF OF ALL—
Prove our claims that Everson SterElators are
DEPENDABLE—SAFE—EFFICIENT
Easy to operate at LOW MAINTENANCE COST.
Everson SterElators METER-MIX-FEED
Chlorine gas accurately for all Water
or Sewage Sterilizing demands.
Furnished for Manual or Automatic operation.
Everson SterElators utilize a high Vacuum.
The indicating FLOW METERS have a 10 to 1 ratio.

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THE
MAGNETITE FILTER

with successful operating records, extending back as much as 18 years, is available for improving the effluent or increasing the capacity of treatment plants for sewage and trade wastes.

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FILTER CORPORATION
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HOW TO "BRIDGE THE GAP" In a Sewer Budget

Sewerage dollars cover more ground when you use Armco Corrugated Metal Structures.

There is a type and size for every need from 6-inch round pipe to 24-foot MULTI-PLATE Arch. Problems of erosion, corrosion and limited headroom are quickly solved. You save in handling and hauling because Armco Structures are light in weight and often can be nested to save space.

Installation is also economical. Long lengths of standard Armco Pipe mean fewer sections to lay, line and join. Simple band couplers assure speedy, positive connections. Precurved MULTI-PLATE sections are delivered, ready for quick field assembly. Jobs go fast with just a small crew. No special tools are required.

And here is something else. Nearly half a century of underground service proves the lasting economy of Armco Corrugated Metal Structures. They have ample strength and durability to serve for years with little or no maintenance. Let us show you how they save time and money. Call or write today. Armco Drainage & Metal Products, Inc., 2031 Curtis St., Middletown, O.

ARMCO SEWER STRUCTURES

ARMCO

"Standardization of Equipment," by Professor G. L. Jacobson, South Dakota School of Mines & Technology.

"Missouri River Basin Development," by a panel consisting of R. J. Stapf, chief, Sewage Section, Division of Sanitary Engineering, Pierre, moderator; Glen J. Hopkins, officer-in-charge, Division of Water Pollution Control, Missouri Drainage Basin, Kansas City, Mo.; Joseph Grimes, district engineer, Bureau of Reclamation, Huron; and Col. H. H. Hoeffer, Corps of Engineers, district engineer, Omaha, Neb.

"Operation of Diatomaceous Earth Filters at Swimming Pools," by Don Wessel, superintendent, Water Department, Mobridge.

"Pipeline Improvements at Winner," by R. L. Weidman, water superintendent, Winner.

At the Business Luncheon on September 29, the following officers were elected:

President: Plummer Wells, Aberdeen.
Vice-President: Wallace Johnson, Huron.
Secretary-Treasurer: C. E. Carl, Pierre.

The Conference watch was won by John Babcock, city engineer, Watertown.

After adjourning, despite the extremely inclement weather, some 15 or 20 individuals made inspection trips of the Aberdeen water and sewage treatment plants.

CHARLES E. CARL,
Secretary-Treasurer

GEORGIA WATER AND SEWAGE ASSOCIATION

The 1950 Annual Meeting of the Georgia Water and Sewage Association was held at Georgia Institute of Technology, Atlanta, Ga., September 20–22, 1950, in conjunction with the 19th Annual Georgia Water and Sew-

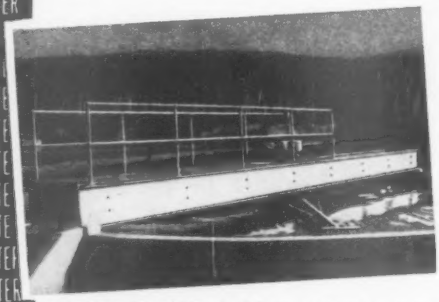
(*Continued on page 110a*)

CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER CARTER

CARTER CIRCULAR COLLECTORS

For sewage treatment, water purification and industrial waste treatment

- For primary clarification of raw sewage, waste or turbid waters
- For final clarification of activated sludge
- For clarification of chemically treated water
- For water softening



Type S Primary Clarifier at Ft. Payne, Ala. 42' 0" dia. x 8' 0" SWD. General Contractors: J. E. Wooley Co., Birmingham, Ala. Consulting Engineers: J. W. Goodwin Eng. Co., Inc. Birmingham, Ala.

The Carter "Type S" Circular Collector is designed for tanks of 10' to 50' in diameter, with side influent. Standard construction includes mechanical electrical overload protection; vertical speed reducer combination type drive; automatic continuous surface skimming—for primary tanks. Plow blade scrapers provide positive, continuous spiral flow of settled solids from tank bottom periphery to central hopper—guaranteeing a thickened sludge. This improved clarification mechanism eliminates both septic conditions and excessive surface scum formations.

Specify CARTER— with confidence

Rotary Distributors • Floating & Fixed Cover Digesters • Alternating Siphons • Paddle Aerators • Sludge Pumps • Rapid & Slow Mixers • Pneumatic Ejectors • Circular Collectors • Flocculation Equipment • Diaphragm Pumps • Self-Priming Centrifugal Pumps • Plunger Pressure Pumps

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Our Bulletin No. 4906 gives you complete engineering data and specifications on all 3 types of Carter Circular Collectors. Write for it today.

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R. B. CARTER SALES INC.
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Some exclusive representative franchises available for select territories on entire Carter line. Write for details.

New Million Dollar Hospital Includes Process Oxidators as Clarification Units For Modern Sewage Treatment Plant!

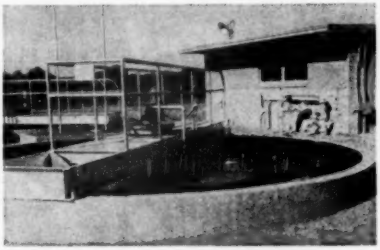
Main building of Pioneer's Memorial Hospital, Brawley, Calif.

General view of plant showing headworks. Oxidators and digester. Nurses home in background.

THE NEW million dollar Pioneer's Memorial Hospital at Brawley, California, is modern in every detail. The sewage treatment plant, which is in close proximity, was designed to include the finest and most up-to-date equipment. Process Engineers Incorporated are proud that Process Oxidators were chosen as the clarification units.

The dual stage bio-oxidation plant was designed for a population equivalent of 1500 and a flow of 150,000 gallons per day. The two 22 ft. dia. Process Oxidators are arranged for parallel or series operation to be used with or without chemicals. Sewage plant designed by Quinton Engineers, Ltd. Prime Contractor: F. E. Young Construction Co. Mechanical Contractor: E. O. Nay Co.

Process Oxidators are now in operation ranging from 15′ in diameter to 115′ in diameter. Every installation has meant lower initial expenditures and higher removal of suspended solids and BOD at greatly reduced cost.



Primary Oxidator. Note aeration in center well, lack of scum and clarity of sewage in sedimentation compartment.

Patented and Patents Pending

Send for Bulletin 106 for information about this new development in sewage treatment. If you have a particular problem, contact one of the offices below and a specialized engineer will be glad to be of service to you.

PROCESS ENGINEERS INCORPORATED

821 MARKET STREET
SAN FRANCISCO 3, CALIF.

6381 HOLLYWOOD BLVD.
LOS ANGELES 28, CALIF.

EASTERN AND MIDDLE WESTERN REPRESENTATIVE:
PACIFIC FLUSH-TANK COMPANY • 4241 RAVENSWOOD AVE., CHICAGO 13, ILL.

age School. A new attendance record of 279 was established.

Following an address of welcome by B. R. Van Leer, president, Georgia Institute of Technology, Federation President A. H. Niles spoke on "Federation Affairs."

Papers of interest to sewage works and industrial wastes personnel included:

"Solution of a Georgia Industrial Waste Problem," by Harry W. Gehm, technical advisor, National Council for Stream Improvement, New York City.

"Financing Water and Sewage Projects," by V. D. Parrott, Jr., superintendent, Water and Light Dept., Dalton.

"Bacteriology of Water and Sewage," by H. A. Wyckoff, Head, Dept. of Public Health, Georgia Institute of Technology.

"Chemistry of Water and Sewage," by N. M. deJarnette, Georgia Department of Public Health.

"Prechlorination Practice," by A. E. Griffin, technical service director, Wallace and Tiernan Co., Newark, N. J.

"Managing a Water and Sewer System," by Lewis W. Turner, city manager, Cedartown.

"Sewerage and Sewage Treatment as a Regional Responsibility," by A. H. Niles, engineer-superintendent, Division of Sewage Disposal, Toledo, Ohio.

"Safety Measures for Water and Sewage Plant Operators," by E. W. Mimms, safety administrator, Celanese Corp., Rome.

"Painting Water and Sewage Works Structures and Equipment," by C. E. Drummond, Jr., engineer, Wiedeman and Singleton, Atlanta.

"Maintenance of Electrical Equipment," by W. J. Seibert, consultant, General Electric Co. Service Shop, Atlanta.

The afternoon of September 21 was devoted to an inspection trip of the LaGrange, Ga., water and sewage

(*Continued on page 112a*)

DEPENDABLE Marlow Pumps... *preferred* from coast to coast!

PLUNGER SLUDGE PUMPS

For removing sludge from settling tank hoppers, for material transfer from digestion tanks to storage units and sludge beds. Bulky debris and nearly solid wastes are routine for these rugged, trouble-free units. In four sizes and two types. Any capacity required.

SELF-PRIMING CENTRIFUGALS

Outstandingly able, these pumps prime and reprime automatically, even on suction lifts. Virtually clog-proof, they will pass an amazing amount of solids. Here are the pumps you can rely on for low-cost, low-maintenance service with clear or semi-clear fluids. From small portables to units of 240,000 GPH capacity.

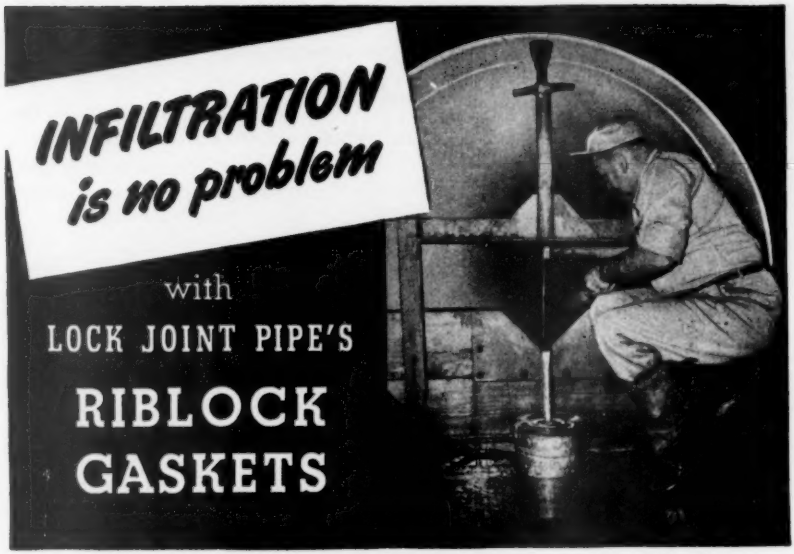
MARLOW MUD HOGS

These popular diaphragm pumps can't be beat for handling mud-filled water, sand and trash-laden liquids. All parts "heavier than necessary" for greater durability. Mud Hogs pump either a gurgle or a gush at each stroke. Capacities to 9000 GPH. Ask especially for details of the new lightweight Mud Hogs.

For complete details see your Marlow distributor or write the factory

MARLOW PUMPS 416 GREENWOOD AVENUE RIDGEWOOD, NEW JERSEY

THE STANDARD OF THE INDUSTRY



Actual field tests made on pipe laid under severe ground water conditions prove that the problem of infiltration can be overcome by using Lock Joint Reinforced Concrete Sewer Pipe equipped with Riblock Gaskets.

Bogert-Childs Associates, consulting engineers for the enormous Overpeck Sewer Project, conducted a detailed weir test on approximately 7,000 feet of 60" Lock Joint Reinforced Concrete Sewer Pipe with Riblock joints which were installed across the North Jersey swamps and marshlands. This test, which showed only 15 per cent of the volume of infiltration permitted in the specifications, pointed conclusively to the value of Lock Joint sewer pipe and Riblock gaskets for installations of this difficult nature.

For nearly 50 years Lock Joint Pipe Company has been furnishing the most durable and dependable sewer, storm drain, and culvert pipe obtainable. Now, by including Riblock Gaskets in the specifications, you can also assure joints with permanently reliable protection against ground water infiltration.

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LOCK JOINT PIPE COMPANY

Established 1905

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BRANCH OFFICES: Casper, Wyo. • Cheyenne, Wyo. Denver, Col. • Kansas City, Mo. • Valley Park, Mo. Chicago, Ill. • Rock Island, Ill. • Wichita, Kan. Kenilworth, N. J. • Hartford, Conn. • Tucumcari, N. M. Oklahoma City, Okla. • Tulsa, Okla. • Beloit, Wis.

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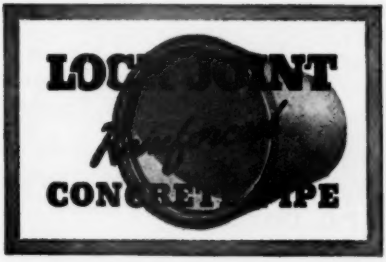

plants, followed by a barbecue supper furnished by the city of LaGrange.

The Annual Banquet was held on September 22. Dinner was by courtesy of the Southern States Chemical Co., Atlanta.

At the Business Meeting immediately following, officers were elected to serve during 1950–51 as follows:

President: V. P. Enloe, Atlanta.
1st Vice President: V. D. Parrott, Jr., Dalton.
2nd Vice-President: L. C. Bowen, Camp Gordon.
Secretary-Treasurer: A. T. Storey, Atlanta.
FSIWA Director: R. Ingols, Atlanta.

A. T. Storey,
Secretary-Treasurer

NEW ENGLAND SEWAGE WORKS ASSOCIATION

The Twenty-Second Annual Fall Meeting of the New England Sewage Works Association was held at the Stratfield Hotel, Bridgeport, Conn., September 28, 1950. Total registration was 121.

The morning program opened with the annual business meeting, at which the following officers were elected for 1951:

President: William S. Wise, Hartford, Conn.
1st Vice-President: E. Sherman Chase, Boston, Mass.
2nd Vice-President: Eugene L. Bond, Greenfield, Mass.
Secretary-Treasurer: Walter E. Merrill, Boston, Mass.

Technical papers presented at the morning session were:

"Importance of Representative Sewage Sampling," by Warren J. Scott, Connecticut State Department of Health.

"Aerobic and Anaerobic Reactions," by F. W. Gilcreas, New York State Department of Health.

"Sampling Times and Schedules," by Prof. E. S. Brown, Jr., Thayer School of Engineering, Hanover, N. H.

"Technique of Collecting Samples," by George G. Bogren, Weston and Sampson, Boston, Mass.

The morning program closed with a round-table discussion of "The Sampling Problem," under the leadership of J. Henry L. Giles, Connecticut State Department of Health.

Following luncheon, Mayor J. McLevy of Bridgeport spoke on "Bridgeport's Part in Pollution Abatement." H. K. Gatley, consulting engineer, then outlined the highlights of Bridgeport's two new sewage treatment plants. The afternoon closed with an inspection of the new East Side sewage treatment plant, which had been placed in operation only a few days previously.

Walter E. Merrill,
Secretary-Treasurer

SEWER AND PIPE CLEANING EQUIPMENT

Sewer Rods, Wood & Steel **Root Cutters, Buckets**
Sewer Machines, Engine Driven & Hand Operated
Steel Tapes, Flushers, Nozzles & Brushes

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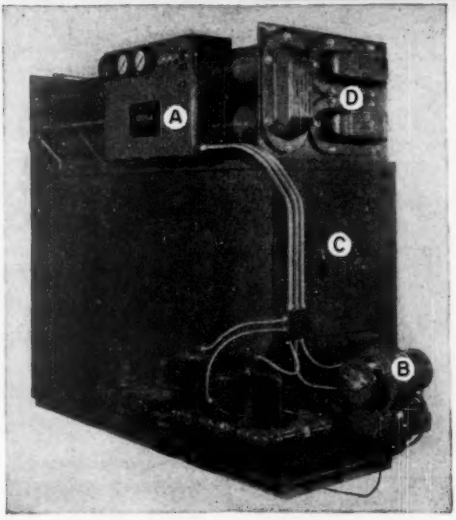
P.O. Box 767 **Syracuse, N. Y.**

WALKER PROCESS **HeatX UNIT**
Digester Heat Exchanger



All main elements are easily removable for inspection, service or replacement by exchange with factory serviced unit.

A. Package Control Panel

B. Package Burner

C. Package Hot Water Tubes

D. Package Exchange Tubes

Above is the Walker Process HeatX Unit . . . combined Boiler and Exchanger.

Designed to provide ABSOLUTE CONTROL over each function of sludge heating

Each function is separate . . . easily and accurately controlled.

Sludge pumps provide forced circulation of sludge from digester through heater tubes, and the hot water pump forces uniform flow of jacket water to maintain desired heated sludge temperatures under highly efficient turbulent flow conditions.

This versatile HeatX Unit is adaptable to all existing installations . . . without changing present boiler. We'll gladly supply complete details.

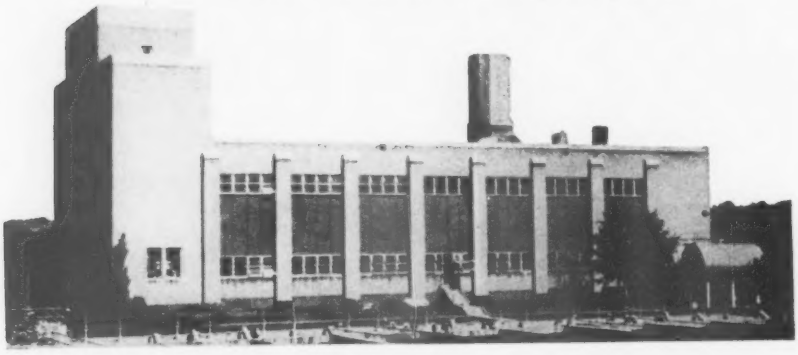
Write For Bulletin 24S24.

Walker Process HeatX Unit installation . . . Separate Style . . . employing existing boiler.

WALKER PROCESS EQUIPMENT INC.
PROQUIP FACTORY • ENGINEERING OFFICES • LABORATORIES
Aurora • Illinois

Low Cost Sludge Incineration

Low cost operation of Nichols Multiple Hearth Incineration at Minneapolis-St. Paul Sanitary District proved over a ten-year period.



Year	Tons Incinerated		Total Cost Operation & Maintenance	
	Dry Solids	Wet Cake	Per Ton Dry Solids	Per Ton Wet Cake†
1940	37,091	116,000	$1.36	$.436
1941	35,993	112,000	1.23	.394
1942	33,838	106,000	1.17	.375
1943	32,955	103,000	1.39	.445
1944	33,758	105,500	1.27	.407
1945	32,428	101,000	1.38	.442
1946	33,581	105,000	1.54	.493
1947	36,633	114,000	1.42	.455
1948	34,549	108,000	1.79	.573
1949	34,787	108,500	1.73	.554
Average	34,56.13	107,900	$1.43	$.457

†Based on average of 68% moisture in filter cake

When increasing population requirements necessitated additional incinerator capacity, the Nichols Multiple Hearth Furnace was again selected. This fourth unit will be in operation shortly.

The operation costs shown in the table* include all salaries, wages, materials, supplies, power, light, water and miscellaneous charges. Also accounted for are all labor costs and materials required for maintenance of the sludge incinerator equipment.

Despite steadily increasing hourly rates for labor and increasing prices of materials and supplies, the attention to operation and maintenance given by the staff has kept operating costs per ton at a low level.

**Figures taken from Annual Reports of Minneapolis-St. Paul Sanitary District 1940-1949.*

NICHOLS ENGINEERING & RESEARCH CORPORATION

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40 S. Los Robles Ave. Pasadena, Calif. • 1477 Sherbrooke St. West, Montreal 25, Canada

SEND FOR MANUAL 149—MODERN PROCESSES AND EQUIPMENT FOR SEWAGE AND INDUSTRIAL WASTE TREATMENT

BIO-ACTIVATION—exclusive system combines best qualities of trickling filter and activated sludge. *Bulletin 259A.*

MECHANICALLY CLEANED SCREENS—with intermittent automatic control. *Technical Supplement-MS*-Complete Design Data.

GRIT CHANNELS—exclusive Camp Chamber design and Regulator permit easy and instant variations in velocity. *Technical Supplement-CR*-Complete Design Data.

GRIT SETTLERS—with conveyor and exclusive Hydrowash unit which removes grease and organic matter from grit. *Bulletin 249.*

GREASE FLOTATION UNIT—removes grease and oils, oxidizes odors, and aerates by exclusive pretreatment method. *Bulletin 260A.*

SLUDGE COLLECTORS—for rectangular and circular tanks . . . flight type and helicoid cross conveyors, sludge valves. *Bulletin 253A.*

AERATORS—downflow mechanical air diffusion type provides thorough and adjustable oxygenation and circulation of liquor. *Bulletin 265.*

JET AERATION—exclusive method produces an unprecedented rate of oxygen absorption. *Technical data available.*

ROTARY DISTRIBUTORS—reaction and positive drive types with exclusive trouble-free oil seal. *Bulletin 257.*

DOWNFLO FLOCCULATION UNIT—for slow mixing and flocculation of chemicals in sewage treatment processes. *Bulletin 266.*

Send for instructive bulletins listed above

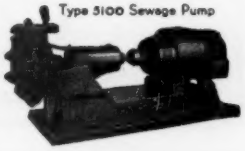
COMPLETE LINE . . .

Including many Exclusive Developments

Many years of close collaboration in the engineering of municipal and industrial waste treatment plants have enabled us to develop a complete line of installation-tested equipment. Our staff of Sanitary Engineers is exceptionally well qualified to cooperate with consulting and operating engineers in suggesting the process of treatment and type of equipment best suited to individual needs.

SEWAGE AND SLUDGE PUMPS

American sewage and sludge pumps are unusually strong and rugged in construction. Generous shaft diameter, sturdy bearings, proper bearing span, finest materials, extra metal, careful inspection and testing. ***Send for Bulletins.***


Type 5100 Sewage Pump

Inquiries on new installations or improvements on existing plants will receive prompt attention

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110 North Broadway
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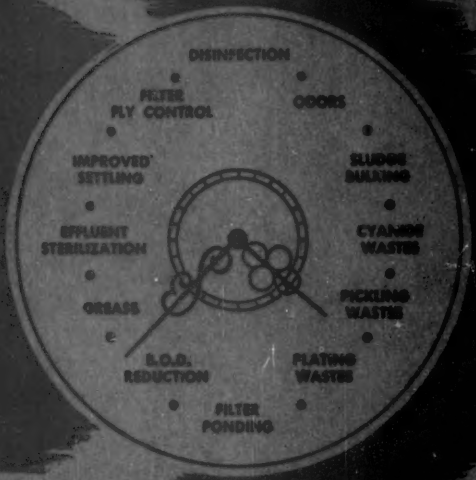

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